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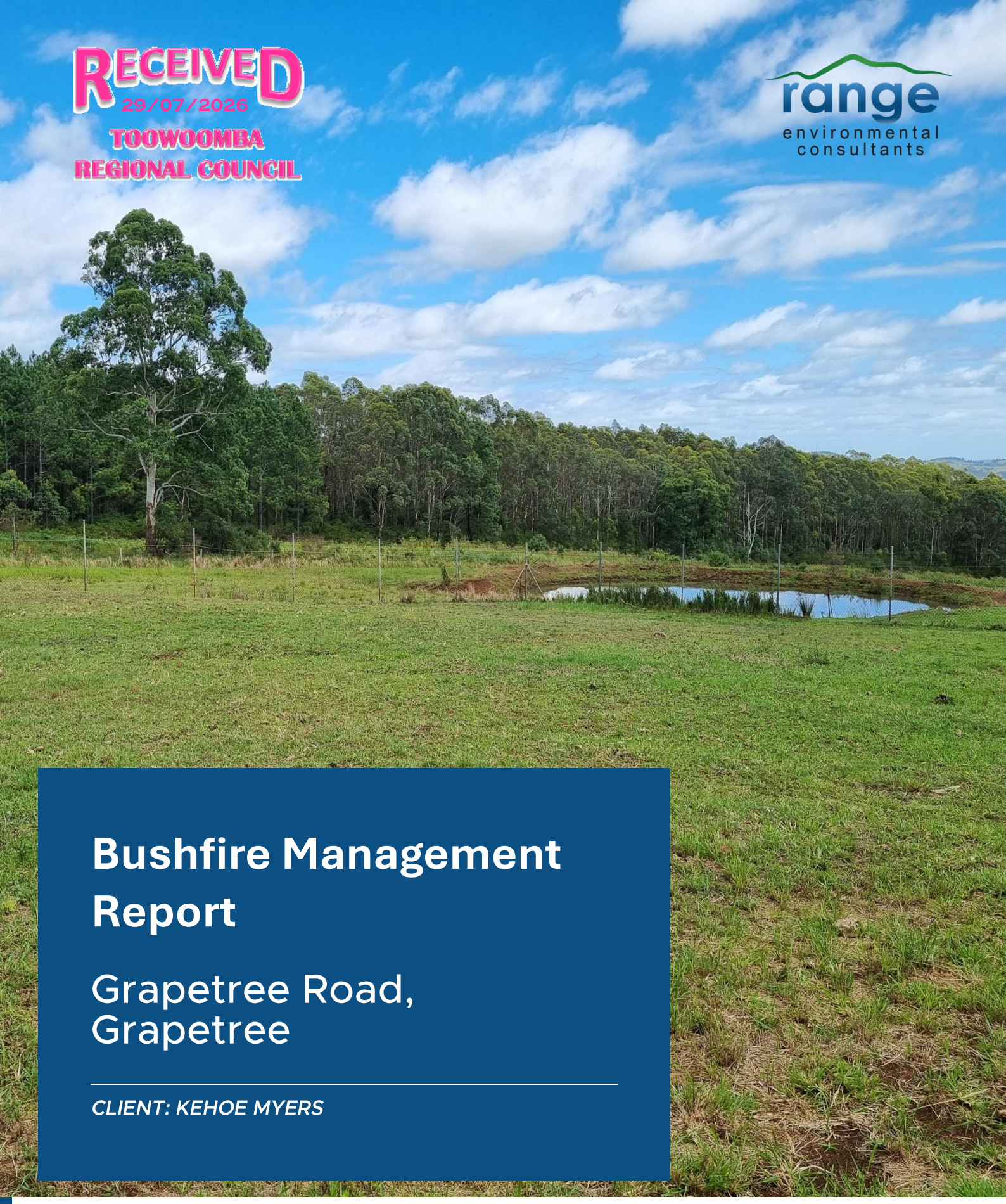

Bushfire Management Report

Grapetree Road, Grapetree

CLIENT: KEHOE MYERS

PROJECT NO.	**J002708**
STATUS	**FINAL**
DATE	**31/03/2026**
VERSION	**1**

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It must be borne in mind that the measures dealt with in this report cannot guarantee that a building will survive a bushfire event. This is due mainly to the unpredictable nature and behaviour of fire and the difficulties associated with extreme weather conditions.

It must also be stated that this report is based on site conditions prevailing at the time the inspection was undertaken. These conditions can and will change dependent on both weather conditions and the maintenance undertaken by property owners.

This fire report has been prepared on the basis that bushfire mitigation measures identified are implemented and maintained into the future. Failure to maintain these measures may contribute to the development being exposed to a higher level of bushfire threat and attack.

As site conditions can and will change over time this report is valid for a period of 2 years. Where a development application is lodged greater than 2 years following the version date of this report Range Environmental Consultants are to be contacted to ensure accuracy of this report.

Document Control

Version	Purpose	Lead Author	Reviewer	Approved by	Date
1.	Final Report	SM	WG	LMT	31/03/2026

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1 Introduction

Range Environmental was engaged by Kehoe Myers Consulting Engineers on behalf of Toowoomba Regional Council (TRC) to prepare a Bushfire Management Report for concept design of the new Grapetree Road Reservoir (Figure 1)(formally described as Lot 10 SP106682, hereafter 'the site'). TRC have requested the concept design of a new 400KL reservoir (Figure 2). Additional design works include decommissioning of the existing reservoir, replacement of existing DN 200 pipeline and construction of a pressure relief value downstream of the decommissioned reservoir.

This bushfire hazard assessment is provided as an attached supporting document and allows for assessment against the TRC Planning Scheme (2012 Version 28) Bushfire Hazard Overlay Code and the SPP (2017) Natural hazards, risk and resilience (Bushfire) assessment requirements. A summary of site details is provided in Table 1.

Table 1 Summary of Site Details

Site details	
Address	Grapetree Road, Grapetree
Lot on Plan	Lot 10 SP106682
Area	2223m^2
Local Government Area	Toowoomba Regional Council (TRC)
Planning Scheme/Local Plan	Toowoomba Regional Council Planning Scheme (2012 Version 28)
Vegetation Management Act 1999 (VMA 1999)	Category X
Area Classification/Zone	Rural
Proposed Landuse	Rural

1.1 Site Context and Proposed Development

The site is bounded by Grapetree Road to the west and south (Figure 1). Rural areas are located to the north and east with Open space located to the west and south in association with Pechey State Forest. Rural areas surrounding the site were pasture grazed, with areas of unmanaged vegetation associated with Pechey State Forest.

The site falls to the west with underlying slopes in the order of 6% or 3 degrees and to the north with underlying slopes in the order of 12% or 7 degrees (Figure 3). The lot on plan of adjacent properties are provided in Figure 4 for where references to these are made. The following photographs provide an overview of the condition of the site at the time of site assessment.

Photograph 1 View of VHC 8.1 to the northwest of the site.

Photograph 2 View of VHC 36.1 to the west of the site.

Photograph 3 View to the south of the site of VHC 36.1 and existing separation provided by Grapetree Road reserve.

Photograph 4 View of VHC 40.4 on the reservoir site (Lot 10 SP106682).

Photograph 5 View to the east of VHC 40.4 to the north of the reservoir site (Lot 11 SP106682).

Photograph 6 View to the south of existing separation provided between the site and potentially hazardous vegetation to the west.

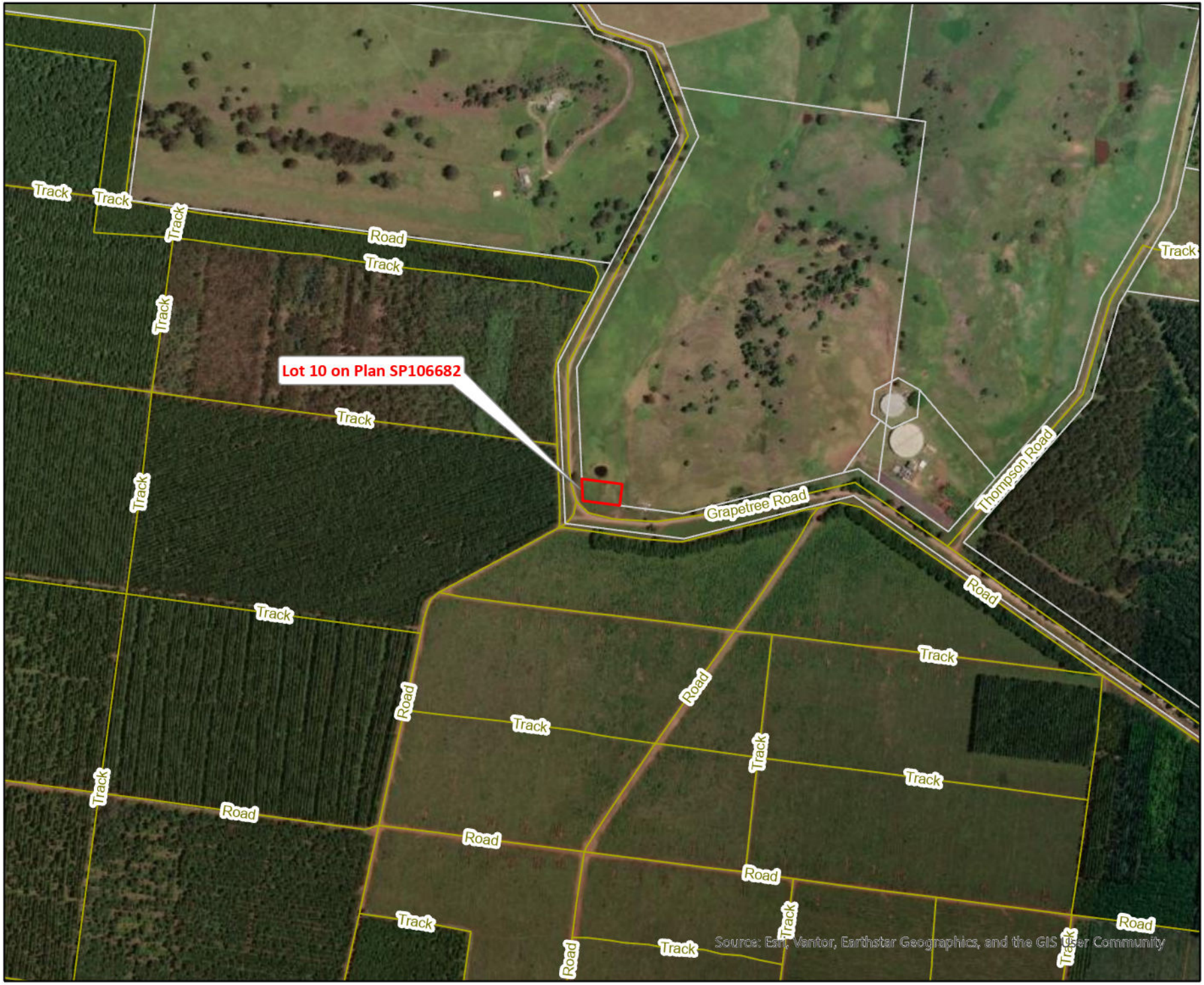

Figure 1 Site Locality

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 17/02/2026
Approved by: Will Gibson Date: 17/02/2026

Metres
0 100 200

Legend

- Cadastre
- Roads
- Proposed Reservoir Site

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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Figure 2 Proposed Development

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 17/02/2026
Approved by: Will Gibson Date: 17/02/2026

Metres
0 20 40

Legend

- Cadastre
- Roads
- 150m Buffer
- Proposed Reservoir Site

The content of this document includes third party data. Range Environmental Consultants does not guarantee the accuracy of such data.

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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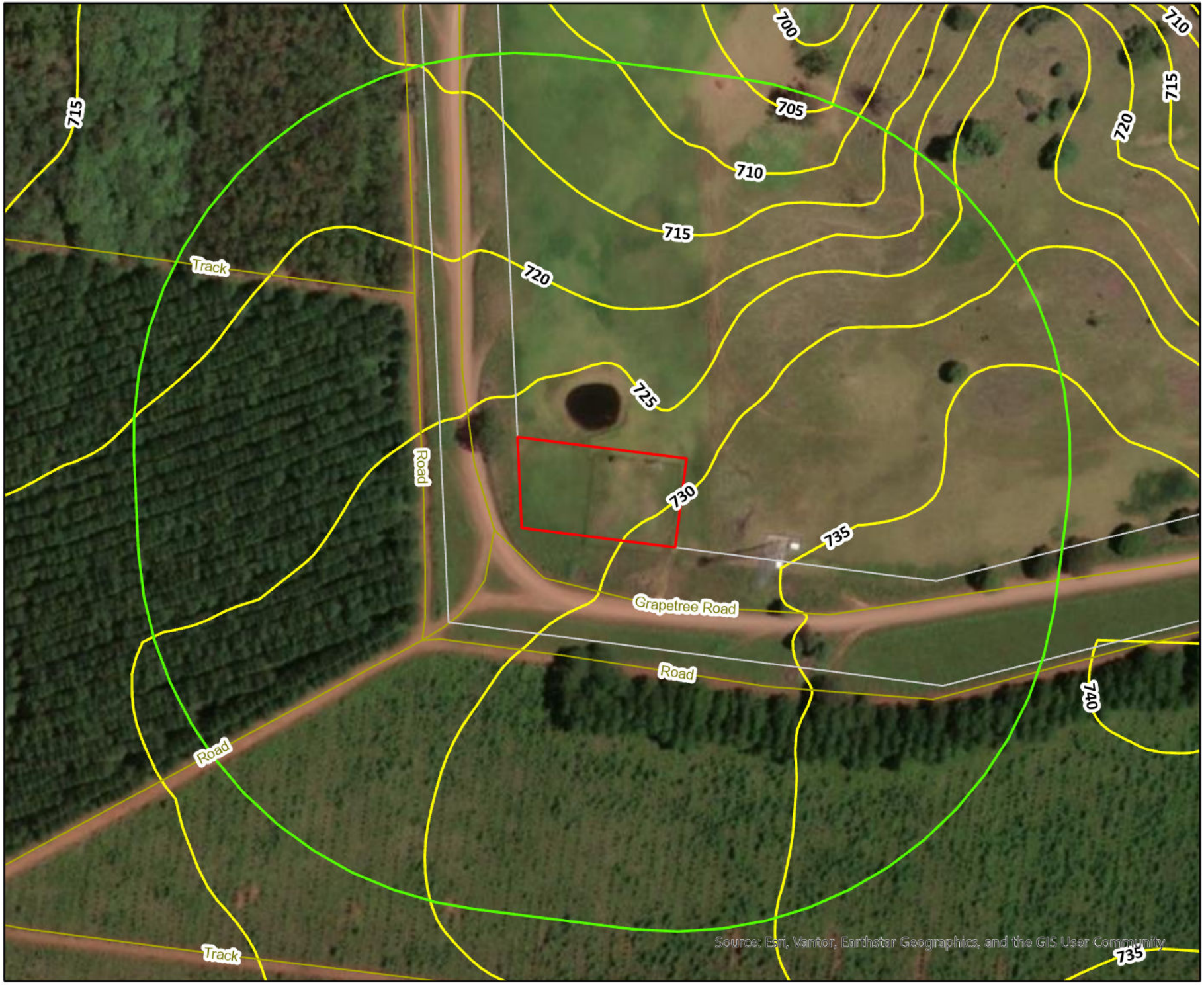

Figure 3 Topography of the Site

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 17/02/2026
Approved by: Will Gibson Date: 17/02/2026

Metres
0 20 40

Legend

- Cadastre
- Roads
- 150m Buffer
- Proposed Reservoir Site
- Contours (5m)

The content of this document includes third party data. Range Environmental Consultants does not guarantee the accuracy of such data.

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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Figure 4
Real Property Descriptions for Adjacent Lots

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 17/02/2026
Approved by: Will Gibson Date: 17/02/2026

Metres
0 25 50

Legend

- Cadastre
- Roads
- Proposed Reservoir Site

The content of this document includes third party data. Range Environmental Consultants does not guarantee the accuracy of such data.

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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2 Vegetation

The current Vegetation Management Supporting Map identifies that vegetation at the site is mapped as Category X (non-remnant) vegetation. Pre-clear regional ecosystem mapping indicates the site contains areas of mapped RE 12.5.6/12.5.13. The field assessment conducted by Range Environment Consultants identified that the site contained an absent canopy layer with a maintained grassy understory.

The extent of mapped vegetation in the area and its conservation status is shown in Figure 5, with Table 2 providing a description of the mapped pre-clear REs.

Table 2 Description of pre-clear regional ecosystems for the site

Regional Ecosystem	12.5.6	**Conservation Status**	Endangered
Description	*Eucalyptus siderophloia, E. propinqua, E. microcorys* and/or *E. pilularis* open forest on remnant Tertiary surfaces. Usually deep red soils		
Regional Ecosystem	12.5.13	**Conservation Status**	Endangered
Description	Microphyll to notophyll vine forest +/- *Araucaria cunninghamii* on remnant Tertiary surfaces		

The information above was sourced from the Queensland Herbarium (2024) Regional Ecosystem Description Database (REDD). Version 13 (May 2024) (DES: Brisbane).

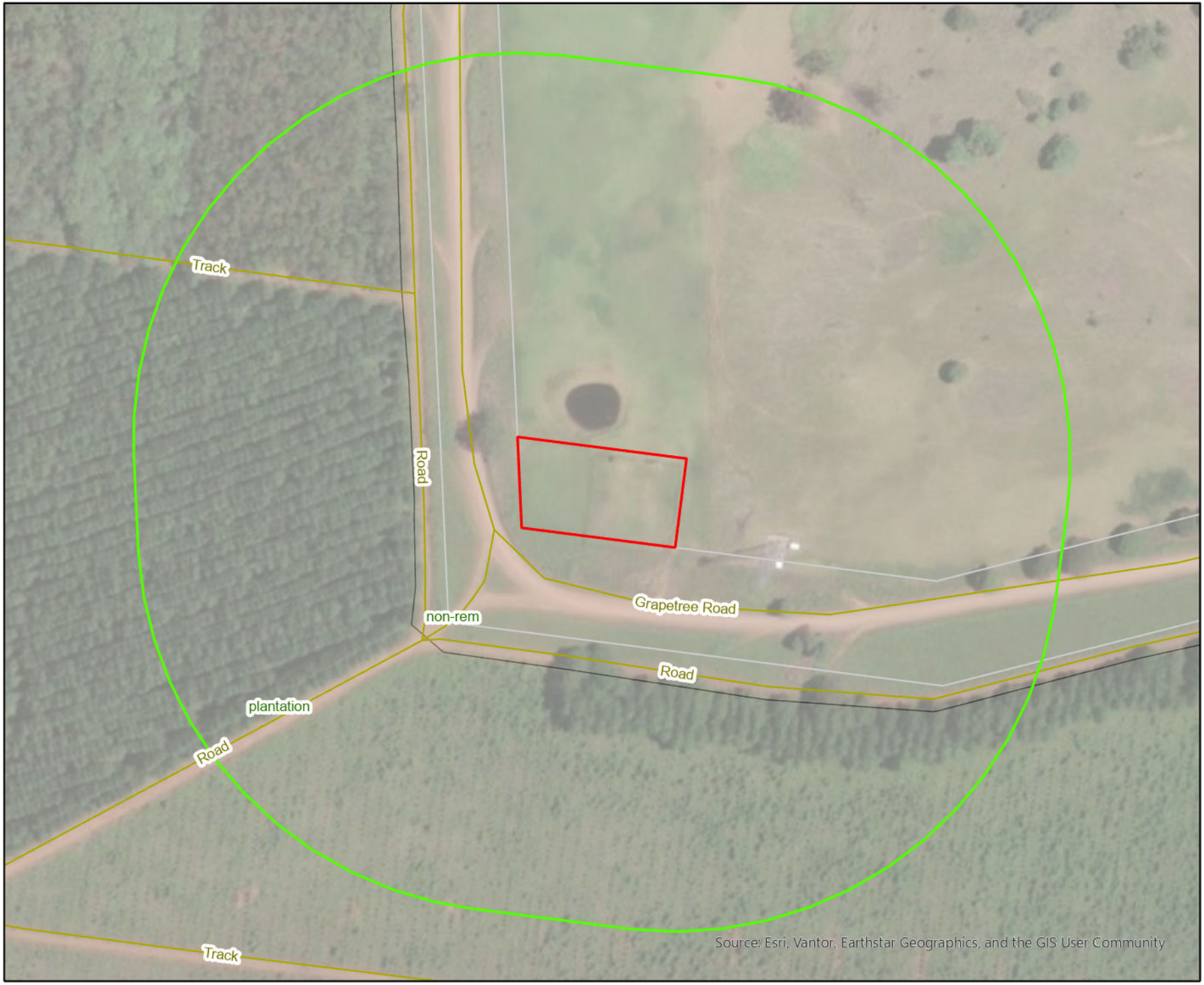

Figure 5
Regulated Vegetation and Regional Ecosystems

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 17/02/2026
Approved by: Will Gibson Date: 17/02/2026

Metres
0 20 40

Legend

- Cadastre
- Roads
- 150m Buffer
- Proposed Reservoir Site
- Non-remnant

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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3 Bushfire

Appendix A provides an overview of the Queensland State-wide mapping methodology used to identify Bushfire Prone Areas.

3.1 Bushfire Hazard Mapping

The bushfire hazard for the site and surrounds as identified by the Queensland Government SPP Interactive Mapping System using the Statewide mapping methodology is shown in Figure 6. The SPP mapping indicates the site contains areas of Potential Impact Buffer. The bushfire hazard for the site and surrounds as identified by the Toowoomba Regional Council (TRC) Planning Scheme Bushfire Hazard Overlay is shown in Figure 7. The site is located outside TRC mapped areas, with areas of Medium Bushfire Hazard in the immediate landscape.

The site assessment identified that the bushfire hazard largely aligns with the levels mapped by the Queensland Government due to unmanaged native and invasive vegetation in the surrounding landscape. Additional details are provided in Section 3.4 which identifies the VHCs present.

Under adverse conditions, a bushfire could potentially approach from the west and south. Severe fire weather conditions are typically associated with hot strong westerly to northerly winds. Bushfires in the area have the potential to generate quantities of embers that could impact on a building even though the fire does not necessarily reach it.

A field assessment was conducted to confirm the vegetation hazard classes (VHCs) present within and surrounding the site and the level of exposure to bushfire risk. VHCs are discussed in Section 3.4.

3.2 Fire Brigade

The development site is contained within the Queensland Fire and Rescue Service Crows Nest Rural Command. The closest fire brigade equipped to fight structural fires is the Crows Nest Fire and Rescue Station (auxiliary) located at 28 Creek Street, Crows Nest approximately 7 kilometres by road to the northwest of the site.

3.3 Fire Run

The length of fire run influences the area in which a fire has to develop and reach its potential maximum intensity for the conditions prevailing at the time. It is important to assess the length of fire run to determine the potential scale and intensity of fires that may occur in the area. Fire runs less than 1 kilometre in length are generally considered to pose a lesser risk than those with a longer run. Fire runs may be modified by natural features such as creeks, rock formation and vegetation types and be influenced by weather and fuel conditions.

A fire of approximately 0.7km to the northwest, 2.5km to the west and 3km to the south is identified in association with Pechey State Forest and are fragmented by Grapetree road and state forest tracks. Figure 8 shows the location of potential fire runs and the areas of the development that could be impacted on by a bushfire.

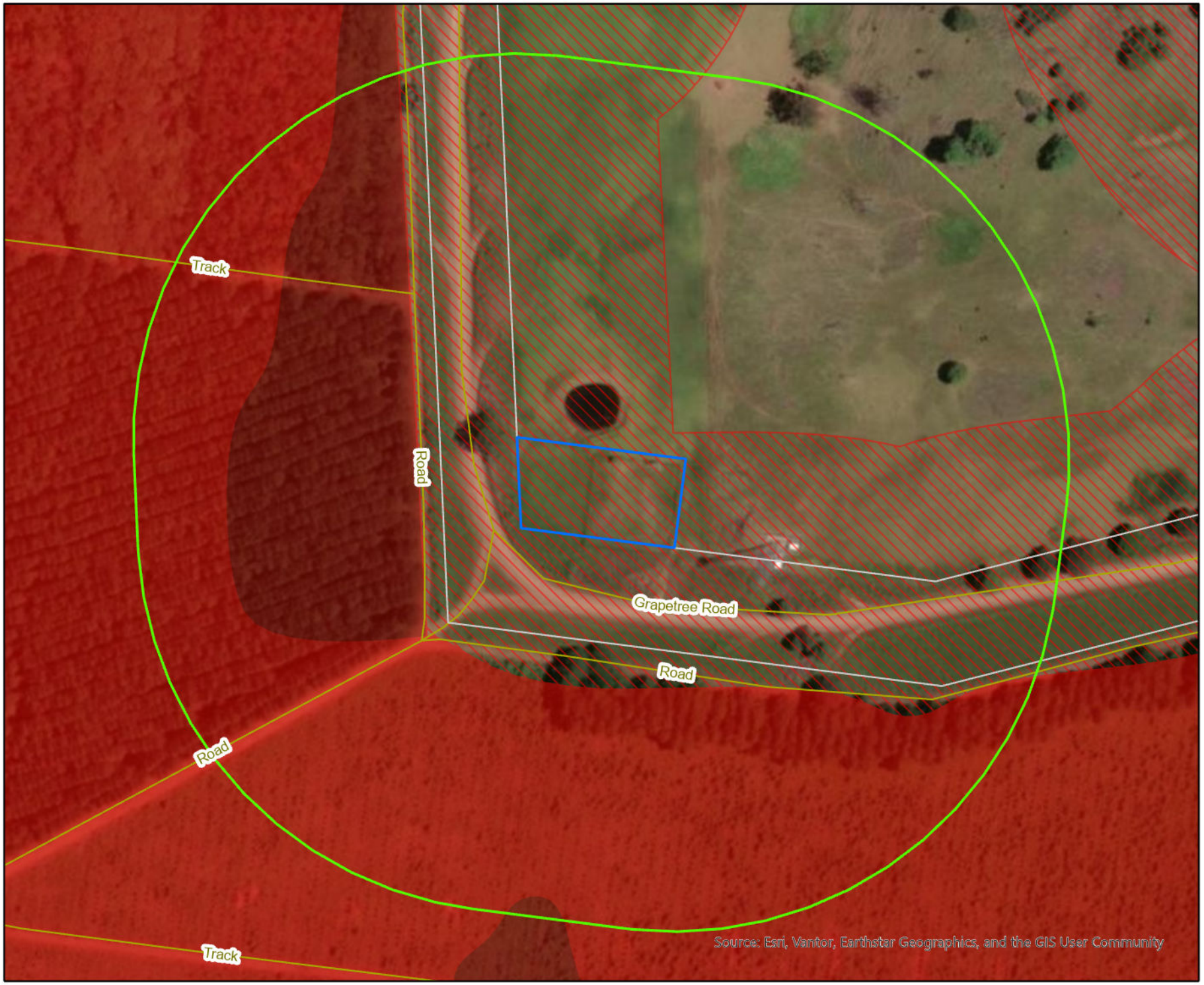

Figure 6
SPP Bushfire Hazard Map

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 17/02/2026
Approved by: Will Gibson Date: 17/02/2026

Metres
0 20 40

Legend

- Cadastre
- Roads
- 150m Buffer
- Proposed Reservoir Site
- Very High Potential Bushfire Intensity
- High Potential Bushfire Intensity
- Medium Potential Bushfire Intensity
- Potential Impact Buffer

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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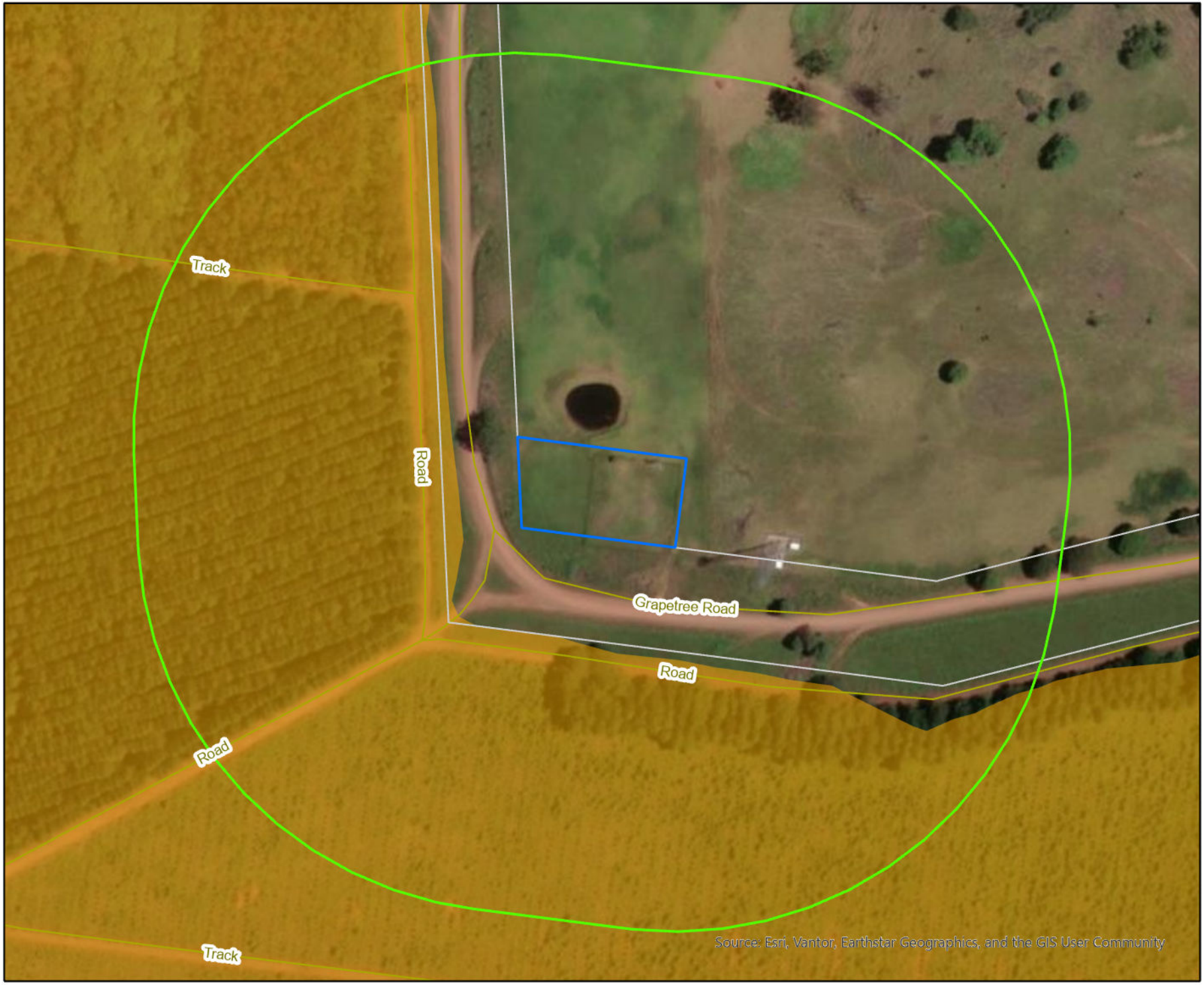

Figure 7
TRC Bushfire Hazard Map

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 17/02/2026
Approved by: Will Gibson Date: 17/02/2026

Metres
0 20 40

Legend

- Cadastre
- Roads
- 150m Buffer
- Proposed Reservoir Site
- High Bushfire Hazard
- Medium Bushfire Hazard

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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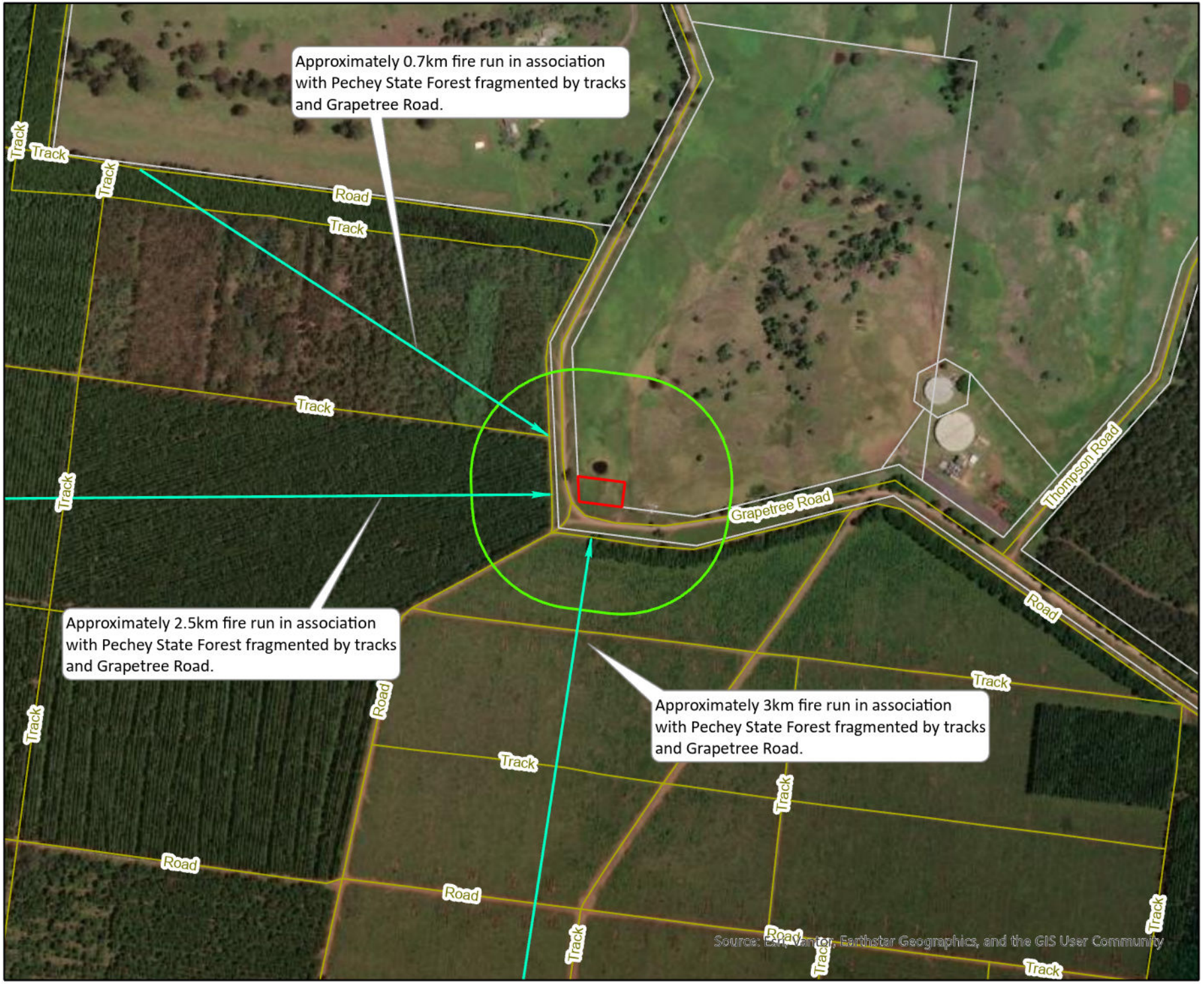

Figure 8 Potential Fire Runs

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 19/02/2026
Approved by: Will Gibson Date: 19/02/2026

Metres
0 80 160

Legend

- Cadastre
- Roads
- 150m Buffer
- Proposed Reservoir Site
- Potential Fire Runs

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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3.4 Vegetation Hazard Classes

A field assessment was conducted to confirm the vegetation hazard classes (VHCs) present within and surrounding the site and the level of exposure to bushfire risk. Appendix A provides an explanation of the statewide methodology used to calculate potential fuel loads and VHCs.

The VHCs mapped for the site and immediate adjoining areas by the State-wide mapping methodology were VHC 8.1 Wet eucalypt tall open forest, VHC 36.1 Exotic and hardwood plantation, VHC 40.4 Continuous low grass or tree cover and VHC 42.6 Nil to very low vegetation cover (Figure 9).

Range Environmental completed a detailed site assessment to facilitate preparation of a representative vegetation hazard class map in relation to the site. Based on detailed field assessment, a site-based vegetation hazard class map has been produced to accurately determine potential bushfire hazards and resulting building requirements for the site.

Vegetation in the greater surrounding landscape (within 150m radius) aligned predominantly with VHC 36.1 to the southwest and south in association with the Pechey State Forest, VHC 8.1 to the northwest and VHC 40.4 to the north and east. The ground truthed VHCs for the site and surrounds are shown in Figure 10. Following development of the site, the post-development VHC map will replicate the ground-truthed VHC map with the reservoir site currently located in a maintained area.

Table 3 provides a summary of the mapped and ground truthed VHCs and potential fuel loads.

Table 3 Vegetation Hazard Class and Potential Fuel Loads

Vegetation Hazard Class (VHC)	Surface and near surface Fuel Load (t/ha)	Total Fuel Load (t/ha)	Prone type[1]	Fuel continuity[2]
8.1 Wet eucalypt tall open forest	31.0	35.0	1	1
36.1 Exotic and hardwood plantation	23.8	26.0	1	1
40.4 Continuous low grass or tree cover	4.5	5.0	2	1
42.6 Nil to very low vegetation cover	2.0	2.0	3	2

Fuel load data sources from Bushfire Resilient Communities Technical Reference Guide October 2019

The identification of VHCs determines the extent to which the vegetation contributes to prevailing bushfire hazard. All VHCs are identified as being one of three prone types[1], with prone types being a categorical indicator of the capacity of a VHC to support a significant bushfire. VHCs are also given a binary indicator of fuel continuity[2]. Continuous fuel vegetation generally has a consistent distribution of fuel. Discontinuous fuel types include non-hazardous vegetation or land uses.

VHC 40.4 and VHC 42.6 are considered non-bushfire prone VHCs under Bushfire Resilient Communities (2019) and BAL calculations using the SPP APZ calculator involving these VHCs results in a radiant heat flux of 0kW/m^2 (BAL-Low). VHC 40.4, while listed as a grass fire prone VHC with a continuous fuel load under Bushfire Resilient Communities (2019), is considered a non-hazardous VHC due to low fuels loads of 5t/ha or less and calculations using the SPP APZ calculator involving this VHC results in a radiant heat flux of 0kW/m^2 (BAL-Low).

The development is located in areas of VHC 40.4, which has been assessed as having Potential Bushfire Hazard Class of 'Low hazard' (further detailed in Section 3.5).

[1] Prone type: 1= Bushfire prone, 2 = Grass fire prone, 3 = Low hazard

[2] Fuel continuity: 1= Continuous, 2 = Discontinuous

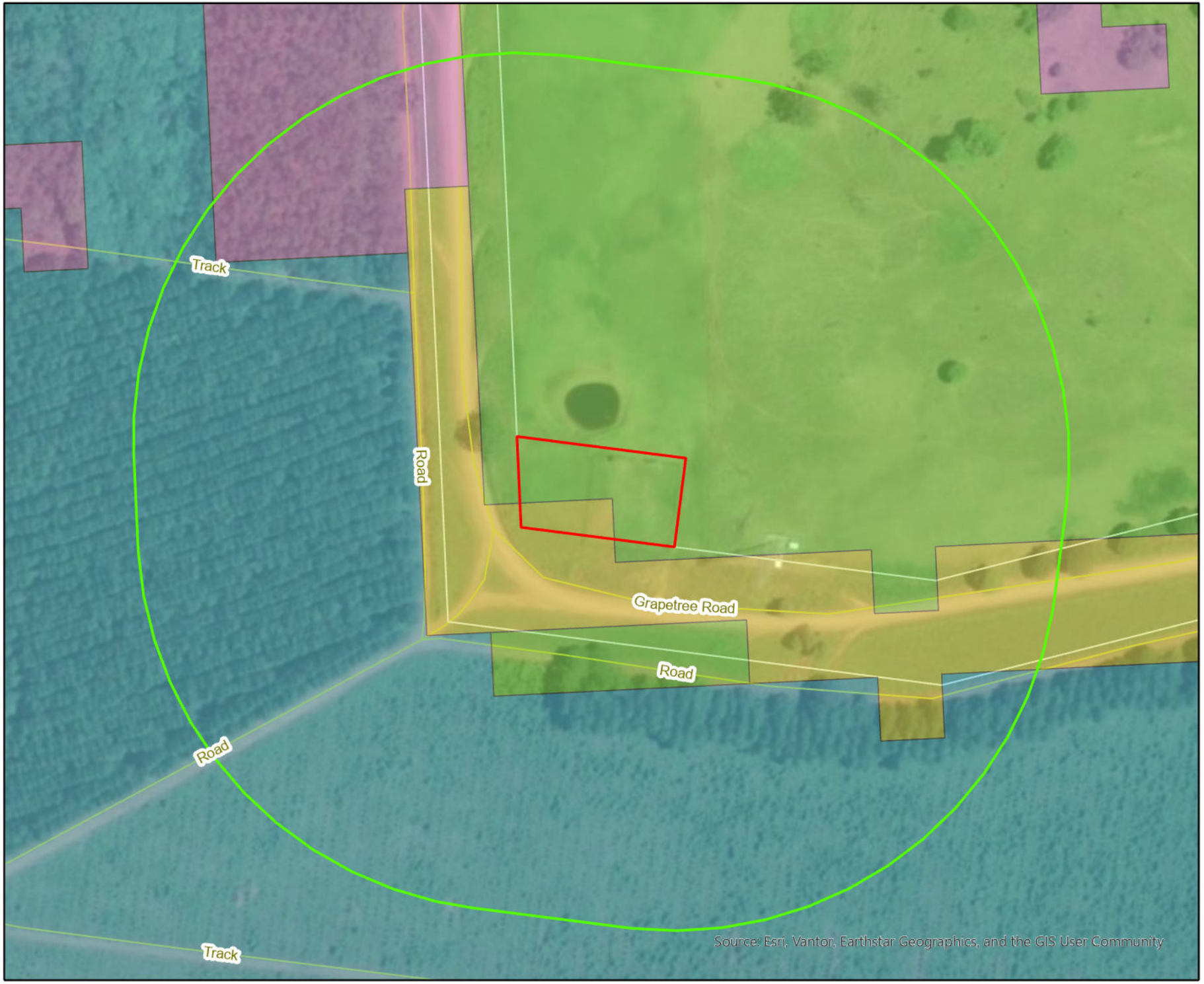

Figure 9 Vegetation Hazard Class Mapping

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 17/02/2026
Approved by: Will Gibson Date: 17/02/2026

Metres
0 20 40

Legend

- Cadastre
- Roads
- 150m Buffer
- Proposed Reservoir Site
- 8.1 Wet eucalypt tall open forest
- 36.1 Exotic & hardwood plantation
- 40.4 Continuous low grass or tree cover
- 42.6 Nil to very low vegetation cover

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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Figure 10 Ground-truthed VHCs

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 18/02/2026
Approved by: Will Gibson Date: 18/02/2026

Metres
0 20 40

Legend

- Cadastre
- Roads
- 150m Buffer
- Proposed Reservoir Site
- 8.1 Wet eucalypt tall open forest
- 36.1 Exotic & hardwood plantation
- 40.4 Continuous low grass or tree cover

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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3.5 Potential Bushfire Hazard Classes

A 'fit for purpose' approach was undertaken to identify the bushfire risk present using the statewide mapping methodology in conjunction with local-scale vegetation and slope maps. The location of ground-truthed VHCs on the site and in the surrounding landscape in conjunction with the underlying slope of land was utilised to develop Potential Bushfire Hazard Classes. The Potential Fireline Intensity calculator was used to calculate the Potential Fireline Intensity (kW/m) to which a Potential Bushfire Hazard Class was attributed. The maximum slope in any direction was used for each area of identified ground-truthed VHC as outlined in Figure 10. Potentially hazardous vegetation is located downslope and upslope/level with the proposed development. Table 4 provides the various site attributes used to calculate the Potential Bushfire Hazard Class at representative locations around the site. Table 5 provides the correlation between Potential Fireline Intensity and Potential Bushfire Hazard Class.

Table 4 Attributes used to calculate the Potential Bushfire Hazard Class

Vegetation Hazard Class (VHC)	Potential Fuel Load (t/ha)	Potential Fire Weather Severity (FFDI)	Slope under hazardous vegetation (deg)	Potential Fireline Intensity (kw/m)	Potential Bushfire Hazard Class
8.1 Wet eucalypt tall open forest	35.0	61	3	56,984	Very High
36.1 Exotic and hardwood plantation	26.0	61	3	31,446	Very High
40.4 Continuous low grass or tree cover	5.0	65	7	1533	Low

Table 5 Potential Bushfire Hazard Classes

Potential Bushfire Intensity Class	Potential Fire-line Intensity
1. Very high (potential intensity)	40,000+kW/m
2. High (potential intensity)	20,000 – 40,000kW/m
3. Medium (potential intensity)	4,000 – 20,000kW/m
4. Low hazard (potential impact buffer)	<4,000kW/m

Areas assessed as Low hazard within a 100-metre radius of vegetation mapped as comprising Medium Potential Intensity or higher were classified as 'Potential Impact Buffer'.

Figure 11 identifies a ground-truthed potential bushfire hazard map for the site. The maximum slope in any direction was used for each area of identified ground-truthed VHC as outlined in Figure 11.

Additional details on the Bushfire Attack Level (BAL) that the site may be exposed to is provided in Appendix D Explanation of Bushfire Attack Levels.

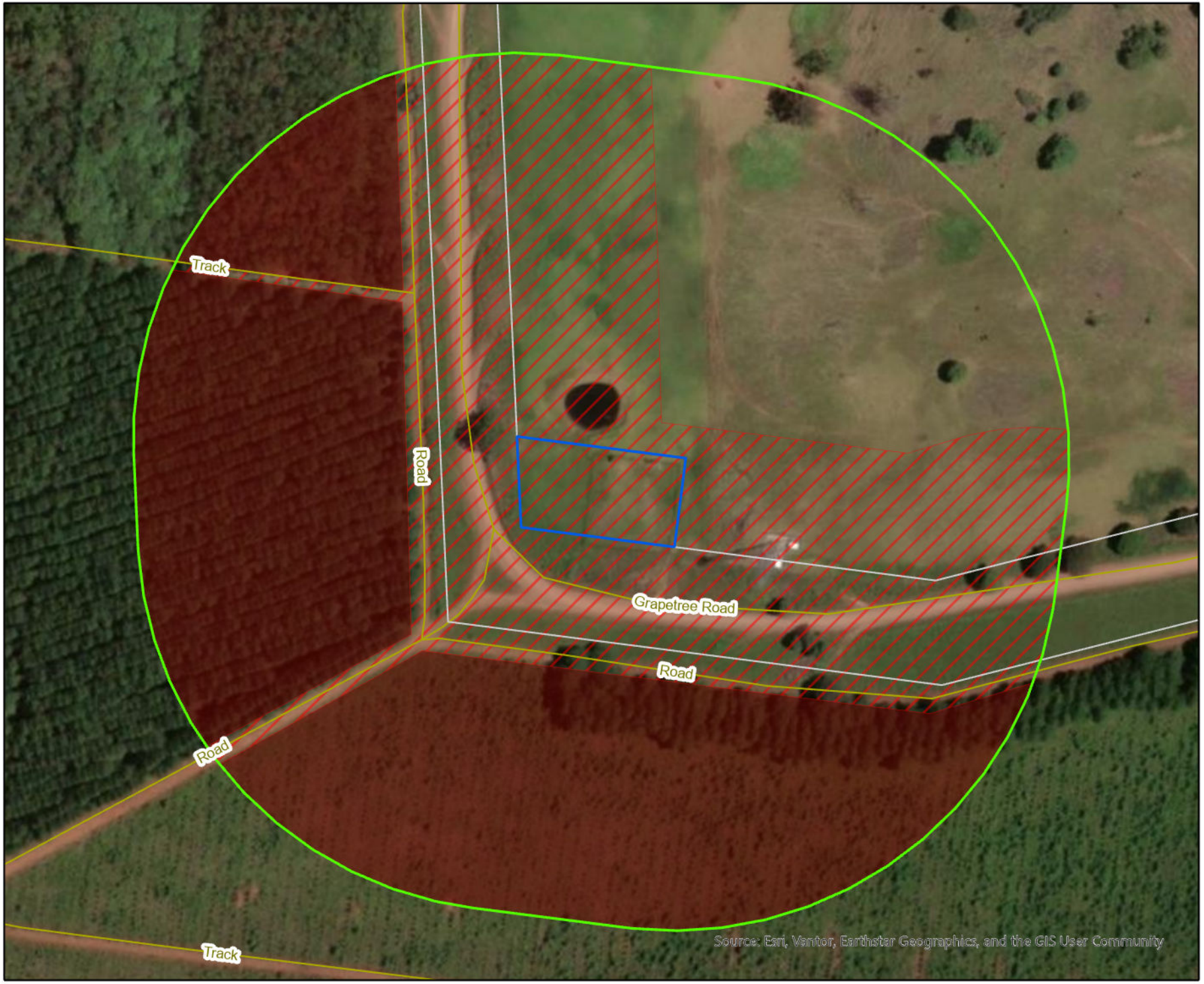

Figure 11 Ground-truthed Potential Bushfire Hazard Map

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 19/02/2026
Approved by: Will Gibson Date: 19/02/2026

Metres
0 20 40

Legend

- Cadastre
- Roads
- 150m Buffer
- Proposed Reservoir Site
- Very High Potential Bushfire Intensity
- High Potential Bushfire Intensity
- Medium Potential Bushfire Intensity
- Potential Impact Buffer

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

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3.6 Bushfire Behaviour

The surrounding terrain has a major influence on bushfire behaviour. A fire will burn faster uphill as the flames can easily reach more unburnt fuel in front of the fire. Radiant heat pre-heats the fuel in front of the fire, making the fuel even more flammable. For every 10˚ slope, the fire will double its speed. For example, if a fire is travelling at 5 km per hour along flat ground and it hits a 10˚ slope it will double in speed to 10 km per hour up the hill. The opposite applies to a fire travelling downhill. The flames reach less fuel, and less radiant heat pre-heats the fuel in front of the fire. For every 10˚ of downhill slope, the fire will halve its speed. This is illustrated in Figure 12.

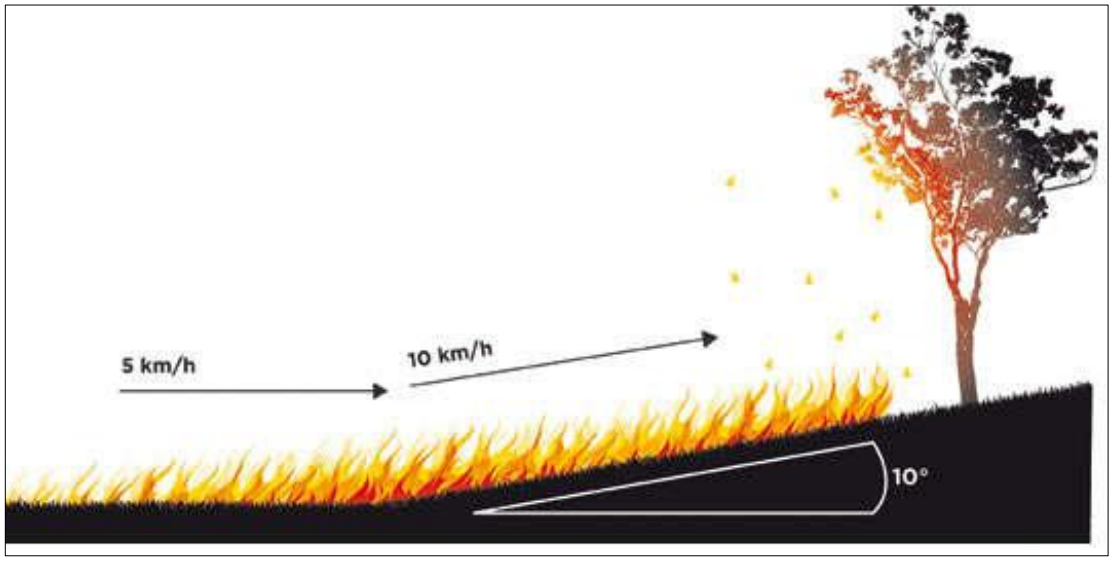

Figure 12 Bushfire rate of spread and increasing slope. Image from Victorian Country Fire Authority

3.7 Likelihood Assessment

The actual or potential severity of a bushfire impacting on the site was evaluated using a standard risk assessment approach. The 'Risk Likelihood Levels' utilised are presented in Table 6.

Table 6 Risk Likelihood Levels

Level	Descriptor	Qualitative Description
A	Almost certain	Is expected to occur in most circumstances, at least on an annual basis or more frequently.
B	Likely	Probable that it will occur; event has occurred several times before in the region.
C	**Possible**	Might occur at some time during the life of the operation.
D	Unlikely	Could occur at some time but is unlikely.
E	Rare	May occur only in exceptional circumstances.

There is the potential for bushfire to occur in the region under adverse seasonal and weather conditions. The risk likelihood level for the site was assessed to be Level C- Possible.

3.8 Consequence Assessment

The consequence of a bushfire impacting on the site was evaluated using a standard risk consequence approach. The 'Risk Consequence Levels' utilised are presented in Table 7.

Table 7 Risk Consequence Levels

Level	Descriptor	Examples
1	Insignificant	People: Event does not result in injury (i.e. no medical treatment required). Environment: No damaged detected. Property: Insignificant damage to property (<$5,000 to repair). Little impact, can be fixed quickly using available resources
2	**Minor**	People: Reversible injury or illness. Environment: Minor impact of short duration or short term damage. Property: Minor damage to property (<$50,000 to repair) Medium impact, can be fixed over time with available resources
3	Moderate	People: Irreversible disability or impairment (30%) to one or more persons. Environment: Short term damage resulting in complaints, localised impact. Property: Moderate damage to property (<$500,000 to repair). High impact, requires significant resources to fix.
4	Major	People: Severe injuries to one or more persons, single fatality. Environment: Significant impact locally and potential for off-site impacts. Property: Major damage to property (<$1,000,000 to repair). Major impact. Fix requires significant resources
5	Catastrophic	People: Multiple fatalities, or irreversible injuries. Environment: Significant impacts to regional ecosystems and threatened species, potential for widespread off site impacts. Property: Significant loss to property (>$1,000,000 to repair) Catastrophic impact (e.g. closure of business, serious injury, death) Large offsite impact, illegal activity

The consequence level for the site was assessed to be Level 2-Minor.

3.9 Risk Level

The 'Likelihood Categories' identified in Table 8 and the 'Risk Categories' identified in Table 8 have been used to assign a risk level to the facility based on consideration of the likelihood and potential consequences of a bushfire event. It is noted that the assigned Risk Category does not take into account the implementation of a range of risk mitigation measures that are being implemented in an appropriate and timely manner as part of the overall ongoing site management. Risk mitigation involves identifying the options for management of the risk, the proposed actions, resource requirements, responsibilities, timing, identifying performance indicators and developing reporting and monitoring procedures.

Table 8 Risk Consequence Levels

Likelihood	Consequence				
	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Almost certain (A)	Medium	High	High	Extreme	Extreme
Likely (B)	Medium	Medium	High	High	Extreme
Possible (C)	Low	**Medium**	High	High	High
Unlikely (D)	Low	Low	Medium	Medium	High
Rare (E)	Low	Low	Medium	Medium	High

Based on the likelihood and consequence assessment, the reservoir tank has been assessed as having a 'Medium' risk of sustaining harm to human health and property in the event of a high intensity bushfire if appropriate site and vegetation management are not followed. This risk level highlights the need for ongoing site management practices to ensure that bushfire hazard and risk are effectively mitigated. Section 4 of this report identifies bushfire hazard and risk mitigation measures that can be utilised to maintain bushfire hazards and risks at an acceptable level, that is, no harm occurs to people or site facilities.

3.10 Risk Assessment

A risk assessment for the proposed reservoir was undertaken to determine the ability for proposed infrastructure to function during and immediately after bushfire events in accordance with PO2 of the Toowoomba Regional Council Planning Scheme (2012 version 28). The following recommendations are made for the proposed development with reference to risk management at the site:

- Maintain vegetation immediately surrounding the infrastructure as low-threat vegetation; and
- Maintain non-flammable materials for proposed infrastructure.

The water reservoir is designed to function during and immediately following an emergency event. Should the reservoir go offline following a bushfire event, the reticulated network can be maintained by using different reservoirs and pumps in the network. It is assumed that the electrical supply to the site and water pipes will be located underground.

The development consists of non-inhabitable infrastructure. In the event of a bushfire, people onsite are to safely evacuate from areas of potential fire hazard onsite.

4 Mitigating Potential Bushfire Impact

A number of actions should be implemented to mitigate the potential impacts of bushfire on the development. This suite of bushfire mitigation measures, when implemented in an integrated manner can achieve a better outcome for the site than when used individually and in isolation from other measures. This suite of potential measures is illustrated in Figure 13.

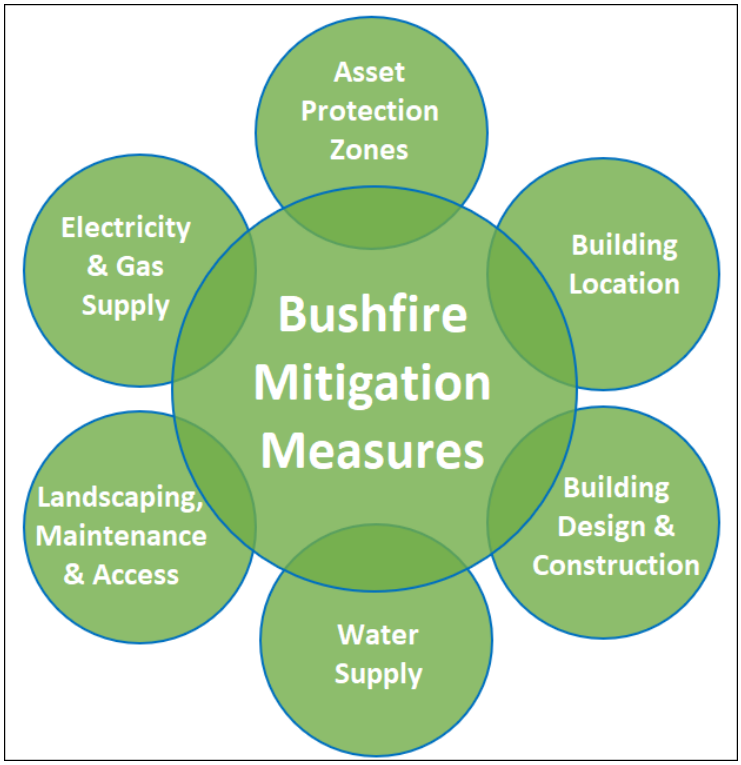

Figure 13 Bushfire mitigation measures in combination (Redrawn from Guideline for Building in Bushfire Prone Areas; Emergency Management Victoria 2016)

4.1 Building Location and Separation

The location of buildings and their relationship with vegetation in the immediate surrounding area is critical for maximising their survival in the event of a bushfire.

Adequate separation exists between the development and potentially hazardous vegetation, provided by existing low threat vegetation on the site and Grapetree Road reserve which allows the development to achieve a maximum radiant heat flux of no greater than 15.12kW/m^2 which is equivalent to a maximum BAL-19, dependent on the final location of the reservoir on the lot.

4.1.1 Asset Protection Zones

The establishment of an Asset Protection Zone (APZ) is an effective mechanism for reducing bushfire hazards that a building may be exposed to. An APZ is a fuel-reduced area surrounding a built asset or structure. Potential bushfire fuels should be minimised within an APZ, so that the vegetation within it does not provide a path for the transfer of fire to the asset either from the ground level or through the tree canopy. An APZ, if designed correctly, implemented, and maintained regularly, will reduce the risk of:

- direct flame contact on the asset;

- damage to the built asset from intense radiant heat; and
- ember attack.

Additional details on creating and managing an APZ are provided in Appendix E Living in a Bushfire Prone Area.

4.2 Building Design and Construction

Careful design of new buildings in areas of mapped bushfire hazard needs to be undertaken, which includes consideration of site characteristics. Buildings should be constructed to meet the requirements of the relevant building standards and Council bylaws prevailing at the time to enable a building to be designed and constructed according to the site conditions. This includes the Building Code of Australia (BCA, 2022) and the Australian Standard for "Construction of buildings in bushfire-prone areas (AS3959 – 2018).

The framework of assessment provided under AS3959-2018 has been utilised to identify Bushfire Attack Levels (BALs) that infrastructure in the proposed development may be exposed to in an event of a bushfire. Existing management allows the development to achieve a maximum radiant heat flux of no greater than 15.12kW/m^2 (Appendix B), which is equivalent to a maximum BAL-19.

It is noted that BALs are based off radiant heat flux and relate to specific requirements for the construction of buildings in bushfire-prone areas in order to improve their resistance to bushfire attack from burning embers, radiant heat and flame contact. BALs are applied to Class 1, 2 and 3 buildings (habitable buildings) and associated 10a structures (sheds, carports etc.). Where this report refers to a structure other than a Class 1, 2, 3 or associated 10a structure this report refers to the radiant heat flux that the structure will be subject to instead. Under the National Construction Code 2022, the proposed water reservoir best aligns with Class 10b buildings or structures. The development is identified as being exposed to a radiant heat flux not exceeding 15.12kW/m^2, which is equivalent to a BAL-19 (Appendix B). This is dependent on individual facilities and their relationship with vegetation in the surrounding landscape. Radiant heat flux levels will decrease with increasing distance from potentially hazardous vegetation.

The bushfire assessment of the site identified that existing infrastructure is within a 'low fuel load' area, with potentially hazardous vegetated areas to the west and south of the site. Mitigation of bushfire risks for the proposed water reservoir is proposed through continuation of existing vegetation management regimes on the site. The site is to be maintained as 'low fuel load' area to minimise the accumulation of hazardous fuel loads.

In assessing vegetation classes for forests, woodlands and rainforests, the classified vegetation will be determined by the unmanaged understorey rather than either the canopy (drip line) or trunk of any trees (AS3959-2018).

Appendix C Calculation of bushfire hazard contains information on the methodologies used to calculate the potential bushfire hazard that the site is exposed to and Appendix D has an explanation of BALs.

4.3 Access and Egress

Access to the site is via Grapetree Road and is a constructed gravel road of all-weather construction. Where a driveway is proposed to the reservoir site it is to be of constructed all-weather access.

4.3.1 Fire Trails

No fire trails are proposed due to good separation from potentially hazardous vegetation provided by the Grapetree Road reserve on the western and southern boundaries of the site.

The proposed water reservoir will be readily accessible by emergency service vehicles. Adequate access to the site is available from Grapetree Road to the south.

4.4 Vegetation Management

The site is entirely mapped as containing Category X (non-remnant) vegetation. Areas of potentially hazardous vegetation are present in the surrounding landscape to the west and south.

Ongoing vegetation management and slashing of long grass will assist in the prevention of potentially hazardous fuel loads accumulating.

4.4.1 Landscaping

The design, management, and maintenance of the landscape in the immediate vicinity of buildings are fundamental to the chances of survival of both people and buildings in a bushfire event. Vegetation provides the major fuel element in a bushfire. All vegetation, regardless of how succulent or green it is will eventually burn, provided the fire has sufficient intensity. Contrary to common belief, the area around the building does not need to be totally devoid of vegetation, and in fact some trees in this area can serve a valuable role in trapping embers before they impact on the asset. It is important however that:

- There are substantial gaps (of at least 2 - 5m) between the canopies of any trees in this area;
- There are no continuous fuels linked horizontally or vertically (smooth barked trees provide a lesser fuel ladder to the canopy than rough barked or ribbon barked species);
- Tree canopies do not overhang the roof;
- Surface and near surface fuels are kept to a minimum. This includes lawns to be kept short (less than 10 cm in height) and removal of accumulated leaf and bark litter;
- Avoidance of flammable mulches on garden beds such as woodchip or straw within 10 metres of dwellings; and
- Use of non-flammable mulches such as river pebbles or stones on garden beds near dwellings and buildings.

Guidelines for landscaping in fire prone areas are provided in Appendix F.

4.5 Water Supply

The TRPS (2012 Version 28) Bushfire Hazard Overlay Code requires that the development be provided with a reliable water supply for fire-fighting purposes that is safely located and freely accessible. The TRPS requires that development be connected to Council's reticulated water supply or provision of an onsite water storage system, for example dam, swimming pool or water tank that permanently holds a minimum of 10,000 litres. As the nature of the development is for a 400kL water reservoir, a secondary onsite water storage system is not required for the development. Rural fire brigade tank fittings are to be provided in accordance with TRPS for the water reservoirs hydrant outlet.

4.6 Prepare, Act, Survive

It is important that residents are well prepared during times of high fire danger and have well made plans that can be readily enacted in a time of bushfire emergency. This includes having plans in place to guide actions on days of extreme and catastrophic, identifying safe refuge areas and planning to either 'stay' or 'go'. The key message being: Prepare, Act and Survive. The Queensland Fire and Emergency Services have information readily available to assist people living in bushfire prone areas to develop their own plans. Details can be downloaded from:

https://www.qfes.qld.gov.au/sites/default/files/2023-06/Bushfire-Safety-Guide_0.pdf and

https://bushfire-survival-plan.qfes.qld.gov.au/

4.7 Maintenance of Bushfire Mitigation Measures

This fire report has been prepared on the basis that bushfire mitigation measures identified are implemented and maintained into the foreseeable future. Failure to maintain these measures may contribute to the development being exposed to a higher level of bushfire threat and attack.

5 Planning Requirements

The Queensland Government's State Planning Policy (SPP) for Natural Hazards (Bushfire) contains development assessment requirements that developments in bushfire prone areas are required to address. Likewise, the TRPS (2012 Version 28) Bushfire hazard overlay code contains provisions to protect the safety of people and property in bushfire risk areas. The Code proposes Performance outcomes and Acceptable outcomes which have been addressed through Proposed Solutions.

5.1 State Planning Policy – Bushfire

The State Planning Policy (July 2017) provides a comprehensive set of principles which underpin Queensland's planning system to guide local government and the state government in land use planning and development assessment. The State's interest in relation to natural hazards is: "The risks associated with natural hazards are avoided or mitigated to protect people and property and enhance the community's resilience to natural hazards". The State Planning Policy (July 2017) development assessment requirements have been addressed in Table 9.

Table 9 State Planning Policy development assessment requirements (Natural hazards, risk and resilience - Bushfire)

Assessment Benchmark	Development Assessment Requirement	Proposed Solution
Applicable development	A development application for a material change of use, reconfiguration of a lot or operational works on premises in any of the following: 1. bushfire prone areas 2. flood hazard areas 3. landslide hazard areas 4. storm tide inundation areas 5. erosion prone area.	Development is a Material Change of Use (MCU) that will result in the demolition of the existing water reservoir and construction of a new 400kL reservoir. Development is proposed in an area identified as bushfire prone.
3	Bushfire, flood, landslide, storm tide inundation, and erosion prone areas outside the coastal management district: Development other than that assessed against (1) above, avoids natural hazard areas, or where it is not possible to avoid the natural hazard area, development mitigates the risks to people and property to an acceptable or tolerable level.	PS1. The development is located in an area of mapped Potential Impact Buffer by the Queensland Government Development Assessment Mapping System Natural Hazards Risk and Resilience mapping (Bushfire). The Toowoomba Regional Council Bushfire Hazard Overlay Code mapping identifies the site is located outside mapped areas and is adjacent to areas of Medium Bushfire Hazard in the adjacent landscape. A site assessment was conducted to confirm the presence of mapped VHC classes and the level of potential bushfire hazard present. A Bushfire Management Plan was prepared that identifies measures to mitigate the risks to people and property to an acceptable level. Included in the hazard assessment were identification of vegetation hazard class (VHC) present and the calculation of Bushfire Attack Levels. Mitigation measures identified include: 1. Maintenance of the site as a 'low fuel load' area; 2. Buildings to comply with relevant standards of building construction including the BCA and AS3959-2018. The development is identified as being exposed to a maximum radiant heat flux not exceeding 15.12kW/m^2, which is equivalent to a BAL-19; 3. Provision of an adequate water supply that can be readily accessed for fire-fighting purposes; and 4. Adequate ingress and egress to the site.

		Provided the measures identified in the bushfire management plan are implemented and maintained, the bushfire risk to people, property and infrastructure can be kept to an acceptable level.
4	All natural hazard areas: Development supports and does not hinder disaster management response or recovery capacity and of capabilities.	PS2. Development, comprising the construction of a water reservoir is proposed to occur at the site in an area mapped by the Queensland Government Development Assessment Mapping System as comprising Potential Impact Buffer. The development actively assists and supports disaster management capacity and capabilities by: 1. Providing ready access to a water supply suitable for fire-fighting purposes. This can be achieved by the proposed water reservoir provided with rural fire brigade fittings for the tanks hydrant outlet; 2. Construction of a driveway to all-weather access; and 3. Managing potentially hazardous fuel loads on the site.
5	All natural hazard areas: Development directly, indirectly and cumulatively avoids an increase in the severity of the natural hazard and the potential for damage on the site or to other properties	PS3. The development takes into consideration topography, location of existing vegetation and potential natural hazards. The site comprises open forest. Mitigation measures identified include: 1. Continuation of vegetation management (mowing/ slashing grass) on the site to prevent the accumulation of hazardous fuel loads; and 2. Landscaping near buildings to consist of plants that have low flammability.
6	All natural hazard areas: Risks to public safety and the environment from the location of hazardous materials and the release of these materials as a result of a natural hazard are avoided.	PS4. Development is a Material Change of Use in an area zoned as Rural. Where the development proposes the storage of chemicals (such as chlorine) onsite, it is to be stored in accordance with the prevailing legislative codes and policy requirements of all levels of government.

7	All natural hazard areas: The natural processes and the protective function of landforms and the vegetation that can mitigate risks associated with the natural hazard are maintained or enhanced.	PS5 The development seeks to maintain and enhance the protective function of landforms and vegetation present on the site by: 1. Retaining the natural landform by minimising the extent of major earthworks required; 2. Ongoing and effective management of environmental weeds on the site; and 3. Ensuring that any landscape plantings are compatible with the natural environment and do not contribute to an elevated bushfire hazard. Incorporation of these measures in the development will enable natural processes and functions to continue and aid in the mitigation of risks associated with potential natural hazards.

5.2 Toowoomba Regional Planning Scheme – Bushfire

The Toowoomba Regional Planning Scheme (TRPS) (2012 Version 28) contains a Bushfire hazard overlay code.

1. The purpose of this code is to protect the safety of people and property in bushfire risk areas.
2. The purpose of the code will be achieved through the following overall outcomes:
    a. development does not increase the exposure of people and property to an unacceptable bushfire hazard risk;
    b. development located in a bushfire risk area is designed to mitigate the bushfire risk through siting, design and management measures;
    c. development provides access and evacuation routes for both private and emergency service vehicles which are appropriate to the nature of the development and the level of bushfire risk;
    d. development for essential community infrastructure is able to function effectively during and immediately after a bushfire event;
    e. public health and safety and the environment are not put at risk by development involving the manufacture and/or storage of hazardous goods in a bushfire hazard area;
    f. the reconfiguration of land appropriately responds to bushfire hazard having regard to the appropriate siting of future development and access for evacuation; and
    g. development provides access to an adequate water supply for firefighting purposes.

This code identifies performance outcomes and acceptable outcomes. Where appropriate, this Code has been applied to the development and outcomes proposed to comply with the accepted development and assessment benchmarks. Table 7 and Table 9 provide responses to the Bushfire hazard overlay code.

Table 10 Bushfire Hazard Overlay Code – requirements for accepted development and assessment benchmarks for assessable development

Performance outcomes	Acceptable Outcomes	Proposed solutions
PO1 Development is provided with an adequate water supply for fire-fighting purposes that is safely located and freely accessible.	**AO1.1** Development within a water supply area involving the creation of a new lot/s or involving proposed and existing buildings with a combined gross floor area greater than 50m^2, is connected to Council's reticulated water supply system It will be readily available at all times for fire fighting vehicles and a water supply outlet located within the road reserve is within 40m of the following: 1. All of the land; or 2. A building envelope designated on each lot; or 3. The centre of each lot, excluding access handles (where no building envelope is designated); and 4. All existing and proposed buildings And Fire hydrants are designed and installed in accordance with Queensland Fire and Emergency Services Fire Hydrant and Vehicle Access Guidelines, unless otherwise specified by the relevant water entity **AO1.2** Development outside a water supply area involving proposed or existing buildings with a combined gross floor area greater than 50m^2, are provided with a dedicated on site water storage system that permanently holds a minimum of 10,000 litres (e.g. dam, swimming pool or water tank) for fire fighting purposes. **AO1.3** A water tank is provided within 10m of each building (other than a class 10 building) which:	**PS1.1** The proposed development does not include residential buildings or inhabitable infrastructure. The TRPS required that development be connected to Council's reticulated water supply or provision of an onsite water storage system, for example dam, swimming pool or water tank that permanently holds a minimum of 10,000 litres. As the nature of the development is for a 400kL water reservoir, a secondary onsite water storage system is not required for the development. Rural fire brigade tank fittings are to be provided in accordance with TRPS for the water reservoirs hydrant outlet.

	a. Is either below ground level or of non-flammable construction; b. Has a take-off connection at a level that allows the following dedicated, static water supply to be left available for access by fire fighters: i. 10,000 litres for residential buildings; ii. For industrial, commercial and other buildings: a volume specified in AS2304- 2011; c. Includes shielding of tanks and pumps in accordance with AS2304-2011; d. Includes a hardstand area allowing medium rigid vehicle (15 tonne fire appliance) access within 6m of the tank; e. Is provided with rural fire brigade tank fittings if serviced by a rural fire brigade (i.e. 50mm ball valve and male camlock coupling and, if underground, an access hole of 200mm (minimum) to accommodate suction lines); and f. Is clearly identified by directional signage at the street frontage	
PO2 Development provides for the safety of people and people by avoiding areas of High or Medium bushfire risk.	**AO2.1** Development is located on land that is not subject to High or Medium bushfire hazard. OR **AO2.2** Where development is located in a High or Medium bushfire hazard area (except for single dwellings on existing lots), it complies with a Bushfire Management Plan for the premises.	**PS2.1** The site is located outside Council's bushfire mapping, with areas of Medium Bushfire Hazard immediatley adjacent in the landscape. Mapping by the Queensland Government identifies the bushfire hazard as comprising Potential Impact Buffer. **PS2.2** A Bushfire Management Plan has been prepared for the site which identifies the standard of building required, emergency fire-fighting water supplies and ingress and egress requirements.
PO3 Development provides for the safety of people and property	**AO3.1** Buildings and structures:	**PS3.1** a. The proposed development is located within a SPP mapped area of Potential

by mitigating the bushfire risk through the siting of buildings.	a. are sited in locations of lowest hazard within the lot; and b. achieve setbacks from hazardous vegetation of 1.5 times the predominant mature canopy tree height or 10 metres, whichever is the greater; and c. are 10 metres from any retained vegetation strips or small areas of vegetation; and d. are sited so that elements of the development least susceptible to fire are sited closest to the bushfire hazard.	Impact Buffer. The proposed reservoir tank is located in proximity to Grapetree Road and pasture grazed areas containing limited canopy vegetation values; b. The water reservoir achieves a minimum setback of >40 metres from areas of hazardous vegetation to the west and south. The height of mature canopy trees on the site is in the order of 10-15 metres. The Australian Standard AS3959-2018 allows for the construction of buildings closer to vegetation than this provided that they are built to a higher standard; and c. The water reservoir is located in an 'low fuel load' area on the site. Infrastructure is location in an area of least hazard on site allowing the water reservoir to be exposed to a maximum radiant heat flux of 15.12kW/m^2 which is equivalent to a BAL-19; d. The water reservoir is sited to maximise separation distances from areas of hazardous vegetation.

Table 11 Bushfire Hazard Overlay Code - assessment benchmarks for assessable development

Performance Outcomes	Acceptable Outcomes	Proposed Solutions
For all Development		
PO1 Community infrastructure is only located in a bushfire medium and high risk area where the function and role of the infrastructure necessitates its location in the area and there are no suitable	No acceptable outcome is nominated.	**PS1** Not applicable. The reservoir is entirely located within an area of Potential Impact Buffer.

alternative sites in a low bushfire hazard area.		
PO2 Community infrastructure is able to function effectively during and immediately after bushfire events.	**AO2.1** The community infrastructure is located on land that is not subject to High or Medium bushfire risk; or **AO2.2** The community infrastructure will not involve any new building work other than a minor extension (<20 m^2 Gross Floor Area) to an existing building; or **AO2.3** The community infrastructure development is located within a bushfire hazard area (as identified in the Bushfire Hazard Overlay Maps) but is designed to function effectively during and immediately after bushfire events.	**PS2.1** The proposed reservoir is located within an area of Potential Impact Buffer. A site specific Bushfire Management Report has been prepared for the site to determine the maximum radiant heat flux not exceeding 15.12kW/m^2 which is equivalent to a BAL-19. The water reservoir is designed to function during and immediately following an emergency event. Should the reservoir go offline as a consequence of a bushfire event, the reticulated network has been designed so that it can be maintained by using different reservoirs and pumps in the network to ensure continuity of water supply. **PS 2.2** Not applicable. The development proposes a water reservoir. The development consists of non-inhabitable infrastructure. In the event of a bushfire, people onsite are able to safely evacuate from areas of potential fire hazard onsite. **PS2.3** A Bushfire Management Plan has been prepared for the site which identifies the standard of building required, emergency fire-fighting water supplies and ingress and egress requirements. The water reservoir is proposed to function during and immediately following an emergency event. Should the reservoir go offline following a bushfire event, the reticulated

		network can adjust by using different reservoirs and pumps in the network.
Water Supply		
PO3 Development is provided with an adequate water supply for fire fighting purposes that is safely located and freely accessible.	**AO3.1** Development within a water supply area involving the creation of a new lot/s or involving proposed and existing buildings with a combined gross floor area greater than 50m^2, is connected to Council's reticulated water supply system. It will be readily available at all times for fire fighting vehicles and a water supply outlet located within the road reserve is within 40m^2 of the following: a. All of the land; or b. A building envelope designated on each lot; or c. The centre of each lot, excluding access handles (where no building envelope is designated); and d. All existing and proposed buildings And Fire hydrants are designed and installed in accordance with Queensland Fire and Emergency Services' Fire Hydrant and Vehicle Access Guidelines, unless otherwise specified by the relevant water entity. **AO3.2** Development outside a water supply area involving proposed or existing buildings with a combined gross floor area greater than 50m^2, are provided with a dedicated on site water storage system that permanently holds a minimum of 10,000 litres (e.g. dam, swimming pool or water tank) for fire fighting purposes. **AO3.3** A water tank is provided within 10m of each building (other than a class 10 building) which:	**PS1.1** The proposed development does not include residential buildings or inhabitable infrastructure. The TRPS required that development be connected to Council's reticulated water supply or provision of an onsite water storage system, for example dam, swimming pool or water tank that permanently holds a minimum of 10,000 litres. As the nature of the development is for a 400kL water reservoir, a secondary onsite water storage system is not required for the development. Rural fire brigade tank fittings are to be provided in accordance with TRPS for the water reservoirs hydrant outlet.

	a. Is either below ground level or of non-flammable construction; b. Has a take-off connection at a level that allows the following dedicated, static water supply to be left available for access by fire fighters: i. 10,00 litres for residential buildings; ii. (For industrial, commercial; and other buildings, a volume specified in AS2304-2011 c. Includes shielding of tanks and pumps in accordance with AS2304-2011 d. Includes a hardstand area allowing medium rigid vehicle (15 tonne fire appliance) access within 6m of the tank e. Is provided with rural fire brigade tank fittings if serviced by a rural fire brigade (i.e. 50mm ball valve and male camlock coupling and, if underground, an access hole of 200mm (minimum) to accommodate suction lines); and f. Is clearly identified by directional signage at the street frontage	
Hazardous Materials		
PO4 Public safety and the environment are not adversely affected by the detrimental impacts of bushfire on the manufacture or storage of hazardous materials in bulk.	**AO4.1** Development complies with a Bushfire Management Plan for the premises.	**PS4.1** Development is to comply with this Bushfire Management Plan. Development is a Material Change of Use in an area zoned as Rural. Where the development proposes the storage of chemicals (such as chlorine) onsite, it is to be stored in accordance with the prevailing legislative codes and policy requirements of all levels of government.
Reconfiguring a lot and Material Change of Use		
PO5	**AO5.1** All development enables buildings and structures to achieve setbacks from hazardous vegetation that are:	**PS5.1**

Lot design and the siting of buildings provide safe sites for habitable and non-habitable buildings.	a. sited within the area of lowest hazard within the lot; and b. provide for adequate setbacks from hazardous vegetation; and c. 1.5 times the predominant mature canopy tree height or 10m, whichever is the greater; and d. 10m from any retained vegetation strips or small areas of vegetation; and e. sited so that elements of the development least susceptible to fire are sited closest to the bushfire hazard.	The development proposed a Material Change of Use for construction of a 400kL water reservoir. a. The proposed water reservoir is located within proximity to Grapetree Road and pasture grazed areas containing limited canopy vegetation values; b. Adequate setbacks from potentially hazardous vegetation are achieved; c. The water reservoir achieves a minimum setback of >40 metres from areas of hazardous vegetation to the west and south. The height of mature canopy trees on the site is in the order of 10-15 metres. The Australian Standard AS3959-2018 allows for the construction of buildings closer to vegetation than this provided that they are built to a higher standard; and d. The proposed water reservoir is greater than 10 metres from any retained vegetation strips or small areas of vegetation; and e. Infrastructure least susceptible to fire is to be located closest to areas of retained vegetation.
PO6	**AO6.1**	PS6.1

For development that will result in multiple buildings or lots, roads and access are designed to mitigate against bushfire hazard by ensuring adequate access for: a. fire fighting and other emergency vehicles; and b. the evacuation of people in the event of an emergency.	The road design is capable of providing access for fire fighting and other emergency vehicles, in accordance with the standards identified in SC6.2 PSP No. 2 – Engineering Standards – Roads and Drainage Infrastructure. **AO6.2** The lot layout ensures that all roads are through roads. **AO6.3** The lot layout does not include long narrow lots, long access ways or rear lots. **AO6.4** The road has a maximum gradient of 1 in 8 (12.5%).	The adjacent road which services the site (Grapetree Road) is capable of providing access to firefighting and other emergency vehicles. PS6.2 N/A PS6.3 N/A PS6.4 Grapetree Road have a gradient not exceeding 12.5% and can be safely navigated by QFES and rural fire brigade and TRC service vehicles.
PO7 For development that will result in multiple buildings or lots, fire breaks are provided that: a. adequately and effectively separate the development site from surrounding vegetation to mitigate against bushfire hazard; b. have sufficient width to enable continuous access for fire fighting and other emergency vehicles, residents and equipment; and c. are in secure tenure and are maintained.	**AO7.1** The development incorporates a fire break provided by a perimeter road that: a. separates the boundary of the lots and the adjacent bushland; b. has a minimum cleared width of 20m; c. has a formed road width of 6m; and d. is constructed to an all weather standard. **AO7.2** The development includes fire breaks which are located as close as possible to the boundaries of the lot(s) and the adjoining bushfire hazard and the fire breaks have: a. a minimum cleared width of 6m; b. a minimum formed width of 4m; c. a maximum gradient of 1 in 8 (12.5%);	**PS7.1-4** Due to the siting and nature of the development, the use of perimeter roads as firebreaks and fire management lines are not proposed. Grapetree Road on the southern and western boundaries of the site provides separation from unmanaged vegetation to the west and south and provides good access and egress for emergency services.

	d. are constructed and maintained to prevent erosion, provide adequate drainage and provide continuous access for fire fighting vehicles; e. provide passing bays and turning areas for fire-fighting appliances; and f. are either located on public land, or within an access easement that is granted in favour of the Toowoomba Regional Council and the Queensland Fire and Rescue Service. **AO7.3** Vehicular access is provided along and at each end of the fire break to existing fire maintenance trails or roads. **AO7.4** The development includes sufficient cleared breaks of 6m minimum width in retained bushland within the development (e.g. creek corridors and retained vegetation) to allow burning of sections and access for bushfire response.	

6 Conclusion

The site assessment identified the proposed water reservoir site is well separated from areas of potentially hazardous vegetation to achieve a maximum radiant heat flux not exceeding 15.12kW/m^2, which is equivalent to a BAL-19. Mitigation of bushfire risks onsite are minimised through the continuation of existing vegetation management regimes to maintain the site as a 'low fuel load' area.

6.1 Recommendations

The following recommendations are made for the proposed development with reference to the ecological values and bushfire management requirements of the site:

- That buildings are designed and constructed to meet the requirements of the relevant building standards prevailing at the time. This includes AS3959 – 2018, the BCA and relevant Council bylaws and building regulations.
- That any landscaping works utilise plant species and design principles suitable for bushfire prone areas and in accordance with Appendix F.
- That the water reservoir is provided with rural fire brigade tank fittings in accordance with the TRPS for the water reservoirs hydrant outlet.
- That where a driveway is proposed to the reservoir site it is to be of constructed all-weather access.
- That bushfire mitigation measures identified in this bushfire management report are implemented and maintained.

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Appendices

Appendix A Queensland Statewide Mapping Methodology

Overview

The Queensland State-wide mapping methodology was used to identify Bushfire Prone Areas on and surrounding the site. This methodology scales bushfire hazard based on the Potential Fire-line Intensity of a severe bushfire and can be used to predict the radiation profile of areas adjacent to potentially hazardous vegetation. The Potential Fire-line Intensity is a useful indicator of the level of safety afforded for resident egress and firefighter access.

The Potential Fire-line Intensity is calculated using 3 key factors operating at a landscape level, these being Potential Fuel Load (tonnes / hectare), Maximum Landscape Slope (degrees) and Fire Weather Severity (Forest Fire Danger Index). Figure 14 illustrates the variables used to determine the Potential Fire-line Intensity.

Figure 14 Variables used to determine Potential Fire-line Intensity. (Redrawn from Leonard et al 2013)

Potential Fuel Load represent the approximate mass (measured in tonnes/ha) of combustible fuel material that would typically accumulate if vegetation is not regularly burnt or subject to fuel reduction practices. Potential fuel loads vary according to the type of vegetation present and management of it. Fuel: its availability, arrangement, size, amount and moisture content contribute to the speed and intensity of a bushfire. The type of vegetation present determines the flammability of the fuel, with the finer and drier the fuel, the more easily it will burn. Fuel loads in general are related to the quantities of fine fuels available to burn. The primary components of fuel loads are the fine fuels; that is; flammable materials that are less than 6 mm in diameter such as leaves, twigs and bark principally on or near the ground.

Slope or steepness of land (described as Landscape Slope) is a major determinant of fire behaviour, controlling fire spread, the rate of fuel consumption and thus Potential Fire-line Intensity.

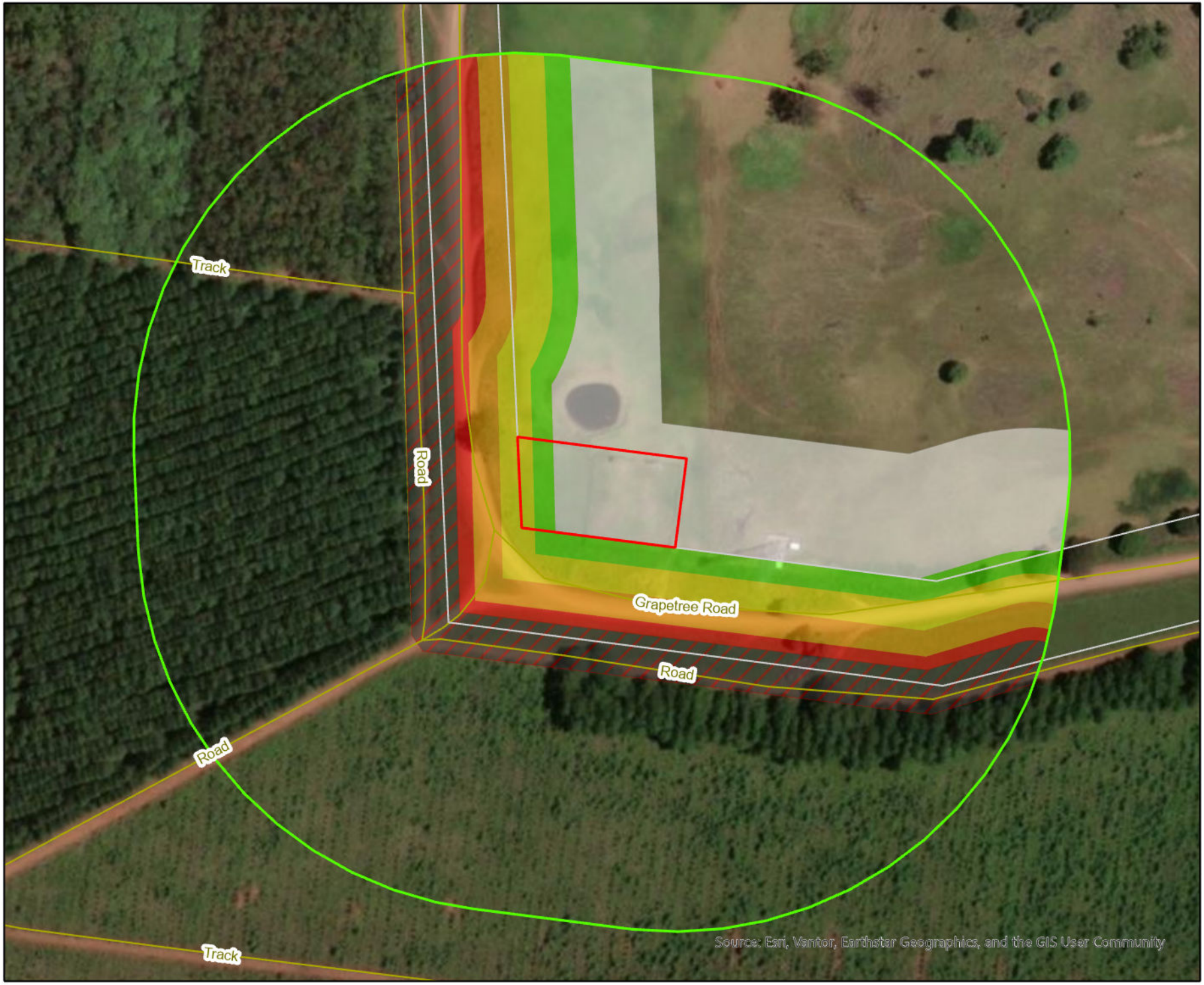
Fire behaviour is influenced by a range of weather variables including recent precipitation, current wind speed, relative humidity, and temperature. Due to the complexity of these influences, they are commonly combined into a single weather index that can be used to estimate potential fire behaviour. The McArthur (1973) Forest Fire Danger Index (FFDI) is the best known, most widely used and thoroughly tested fire weather index adopted by fire agencies throughout Australia.

Fuel Loads and Vegetation Hazard Classes

The new methodology for State-wide mapping of bushfire prone areas in Queensland identifies Potential Fuel Loads that are assigned to vegetation categories (Vegetation Hazard Classes) formed by amalgamating land use and vegetation types with a moderately consistent fuel load and structure. The Potential Fuel Load assigned to each Vegetation Hazard Class (VHC) is generally representative of the higher fuel load expected for the typical vegetation types, landscape, and site conditions within each Vegetation Hazard Class. This Potential Fuel Load of each Vegetation Hazard Class would approximate the 80th percentile fuel load of the “long unburnt condition” for the class (generally greater than 10 years without burning).

The Queensland State Government has introduced a State-wide mapping methodology to identify Bushfire Prone Areas. This methodology was developed by the CSIRO Climate Adaptation Flagship and scales bushfire hazard based on the Potential Fire-line Intensity of a severe bushfire. It is used to predict the radiation profile of areas adjacent to potentially hazardous vegetation. A key component of the methodology is the allocation of Vegetation Hazard Classes (VHC) which are used to estimate Potential Fuel Loads. These fuel loads were derived from a combination of expert appraisals and field measurements using the upper range of fuel loads for each fuel element (i.e., surface, near surface, elevated and bark). A “long unburnt condition” of generally greater than 10 years without burning was used for estimating fuel loads.

Appendix B Potential Radiant Heat Flux Map



Appendix B Potential Radiant Heat Flux Map

Project: Bushfire Management Report, Grapetree Road Reservoir

Client: Kehoe Myers Consulting Engineers

Project No.: J002708

Compiled by: SkyeMelton Date: 31/03/2026
Approved by: Will Gibson Date: 31/03/2026

Metres
0 20 40

Legend

- Cadastre
- Roads
- 150m Buffer
- Proposed Reservoir Site
- <10kW (within 100m of hazardous vegetation)
- 12.5-10kW/m2
- 12.5-19kW/m2
- 19-29kW/m2
- 29-40kW/m2
- >40kW/m2

Source: Cadastral data sourced from DNRME (2025). Aerial imagery sourced from NearMap (2025).

N

range environmental consultants

Appendix C Calculation of Bushfire Hazard

In accordance with SPP guidance material (Bushfire Resilient Communities (QFES 2019)) the vegetation hazard class (VHC) mapping was reviewed and modified to accurately represent the on-ground matters through a field assessment.

Vegetation hazard class and 80th percentile potential fuel load inputs from QFES (2019) were utilised to determine the radiant heat exposure using the QFES SPP Asset Protection Zone Width Calculator.

Determination of Bushfire Attack Level – SPP APZ Calculator

The bushfire hazard that buildings could potentially be exposed to was calculated using the QFES SPP Asset Protection Zone Width Calculator and fuel loads consistent with the post-development VHCs as set out in SPP technical reference guide 'Bushfire Resilient Communities' (2019). AS 3959-2018 identifies the level of construction required for the purpose of ensuring that a building is constructed to withstand a potential bushfire attack. This Standard is primarily concerned with improving the ability of buildings in designated bushfire-prone areas to better withstand attack from bushfire, thus giving a measure of protection to the building occupants (until the fire front passes) as well as to the building itself. AS3959-2018 requires that vegetation be assessed within 100 metres of a building when determining the Bushfire Attack Level.

Bushfire Resilient Communities Technical Reference Guide for the State Planning Policy State Interest 'Natural Hazards, Risk and Resilience - Bushfire' (2019) requires that bushfire hazard is to be assessed within 150m of the development footprint.

Climatic Conditions and Forest Fire Danger Index

The McArthur Forest Fire Danger Index (or FFDI) is the most common proxy of fire weather severity in Australia and is used for bushfire hazard assessments, emergency management and in regulations such as the Australian Standard 3959–2018 Construction of buildings in bushfire-prone areas.

Unlike Queensland's adoption of AS 3959–2018 (Method 1) that uses a single FFDI value for all of Queensland (40), the estimate of fire weather severity used as an input to identifying the SPP bushfire prone areas in Queensland recognises that weather conditions vary across the state.

Spatially explicit 5% annual exceedance probability (AEP) fire weather event FFDI values for Queensland have been estimated from a gridded (83 kilometre, three-hourly resolution) prediction of FFDI from long-term spatial weather products produced by the Australian Bureau of Meteorology (BoM). The adopted FFDI values reflect a 5% AEP weather event. Adopted FWS (i.e., 5% AEP fire weather event FFDI) values for Queensland vary from 50 in Southeast Queensland and Cape York bioregions to 130 in the south-western parts of the state.

Adopting a worst-case scenario, an FDI of 61 was used for the site when calculating Bushfire Attack Levels (BAL) for 'the site'. Figure 15 provides a Fire Danger Index (FDI) map of Southeast Queensland and identifies the location of the site.

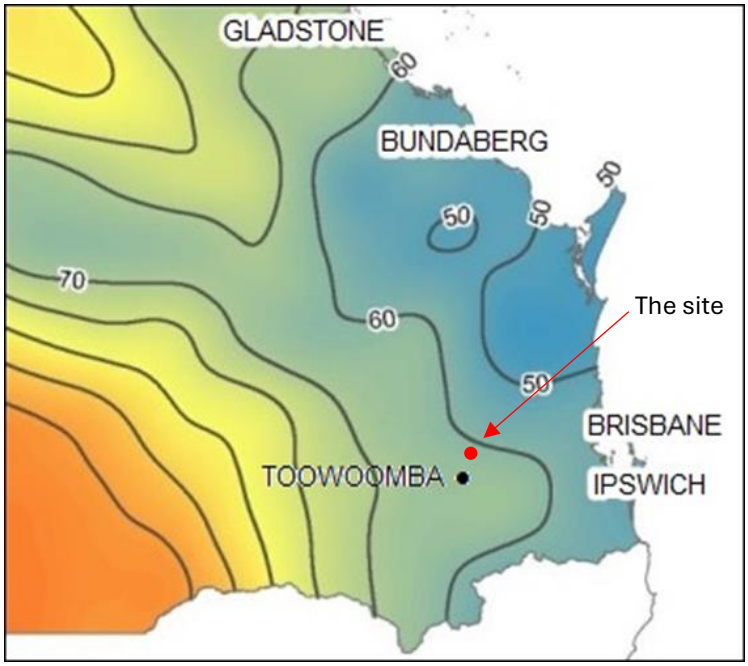


Figure 15 FDI map for Southeast Queensland. Leonard. J. A New Methodology for State-wide Mapping of Bushfire Prone Areas in Queensland. 2014

The potential radiant heat flux was calculated using the SPP APZ Width Calculator for representative areas downslope and upslope/ level with of the site. Figure 16 shows the radiant heat flux vs distance from vegetation and potential BALs.

In assessing vegetation classes for forests, woodlands and rainforests, the classified vegetation will be determined by the unmanaged understorey rather than either the canopy (drip line) or trunk of any trees (AS3959-2018).

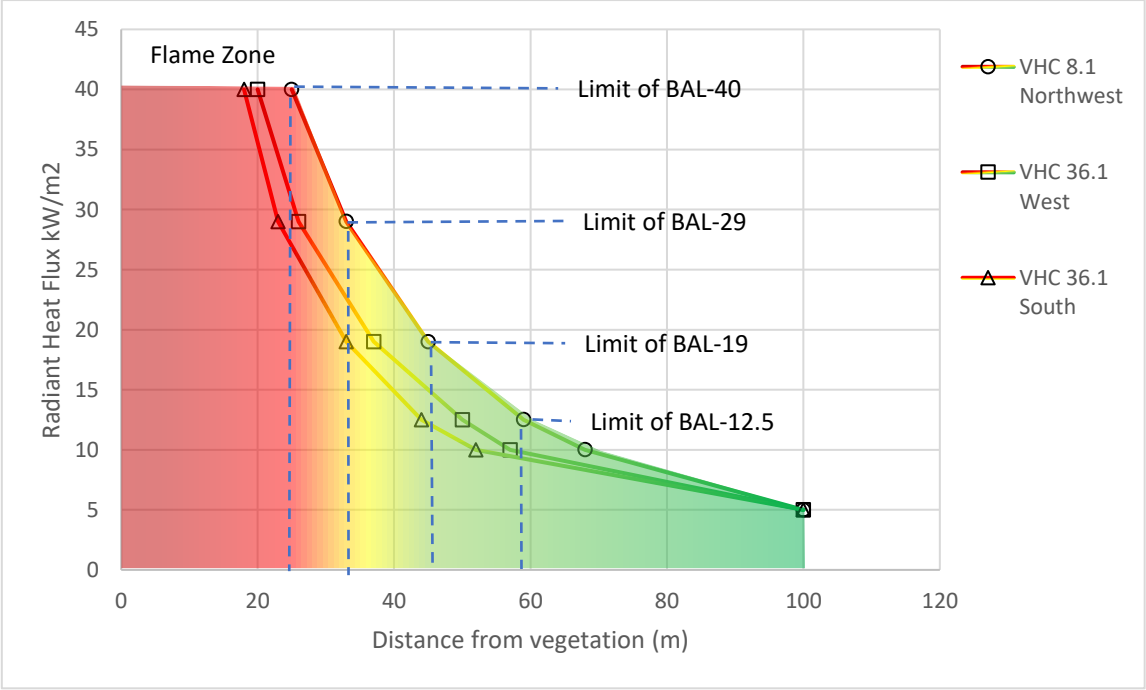


Figure 16 Potential radiant heat flux versus distance from bushland areas (VHC 8.1 and VHC 36.1)

Calculation of Bushfire Attack Level – SPP APZ Calculator

The following steps were carried out using information collected from the relevant site and applying this information to the conditions required and set out in QFES SPP Bushfire Asset Protection Zone Calculator and the Australian Standard 'Construction of Buildings in Bushfire-prone areas' (AS 3959-2018).

Table 12 Parameters used in SPP APZ calculations

Step	Procedure	Value northwest	Value west	Value south
1	Fire Danger Index (FDI)	61	61	61
2	Vegetation Hazard Class (VHC)	8.1	36.1	36.1
3	Surface fuel load (t/ha)	31.0	23.8	23.8
4	Overall fuel load (t/ha)	35.0	26.0	26.0
5	Location of vegetation (Upslope/Downslope)	Downslope	Downslope	Level & Upslope
6	Site slope	3 degrees	3 degrees	1 degree
7	Effective slope of land under classified vegetation	3 degrees	3 degrees	1 degree

In assessing vegetation classes for forests, woodlands and rainforests, the classified vegetation will be determined by the unmanaged understorey rather than either the canopy (drip line) or trunk of any trees (AS3959-2018).

Table 13 to Table 15 provide details of the BAL calculations for the site using the SPP APZ Calculator in relation to the areas of unmanaged vegetation in the vicinity of the development.

Table 13 State Planning Policy Asset Protection Zone Width Calculator (VHC 8.1– downslope northwest)

SPP Bushfire Asset Protection Zone Width Calculator			
VARIABLE DESCRIPTION	**VARIABLE**	**UNITS**	**VALUE**
Input Values			
FIRE WEATHER SEVERITY	**FDI**		61.00
VEGETATION HAZARD CLASS	**VHC**	-	8.1 Wet eucalypt tall open forest
REMNANT STATUS	**-**	-	Non-remnant
SLOPE TYPE (UPSLOPE OR DOWNSLOPE)	**ST**	-	Downslope
EFFECTIVE SLOPE UNDER THE HAZARDOUS VEGETATION	**eSlope**	degrees	3.00
SLOPE BETWEEN SITE AND HAZARDOUS VEGETATION	**θ**	degrees	3.00
DISTANCE OF THE SITE FROM HAZARDOUS VEGETATION	**d**	m	70.00
Output Values			
SURFACE FUEL LOAD	**-**	t/ha	28.00
NEAR SURFACE FUEL LOAD	**-**	t/ha	3.00
BARK FUEL LOAD	**-**	t/ha	2.00
ELEVATED FUEL LOAD	**-**	t/ha	2.00
TOTAL OVERALL FUEL LOAD	**W**	t/ha	35.00
TOTAL SURFACE FUEL LOAD	**w**	t/ha	31.00
POTENTIAL FIRE LINE INTENSITY	**I**	kW/m	50472
RADIANT HEAT FLUX	**q**	kW/m^2	9.44
BUSHFIRE ATTACK LEVEL (AS 3959-2018)	**BAL**	-	BAL 12.5
DISCLAIMER: Fire-line intensity and radiant heat calculations where effective slope exceeds 20 degrees (downslope) or 15 degrees (upslope) may be unreliable. In these locations, specialist assessment is warranted.			

Table 14 State Planning Policy Asset Protection Zone Width Calculator (VHC 36.1- downslope west)

SPP Bushfire Asset Protection Zone Width Calculator			
VARIABLE DESCRIPTION	**VARIABLE**	**UNITS**	**VALUE**
Input Values			
FIRE WEATHER SEVERITY	**FDI**		61.00
VEGETATION HAZARD CLASS	**VHC**	-	36.1 Exotic and hardwood plantation
REMNANT STATUS	**-**	-	Non-remnant
SLOPE TYPE (UPSLOPE OR DOWNSLOPE)	**ST**	-	Downslope
EFFECTIVE SLOPE UNDER THE HAZARDOUS VEGETATION	**eSlope**	degrees	3.00
SLOPE BETWEEN SITE AND HAZARDOUS VEGETATION	**θ**	degrees	3.00
DISTANCE OF THE SITE FROM HAZARDOUS VEGETATION	**d**	m	43.00
Output Values			
SURFACE FUEL LOAD	**-**	t/ha	22.30
NEAR SURFACE FUEL LOAD	**-**	t/ha	1.50
BARK FUEL LOAD	**-**	t/ha	1.20
ELEVATED FUEL LOAD	**-**	t/ha	1.00
TOTAL OVERALL FUEL LOAD	**W**	t/ha	26.00
TOTAL SURFACE FUEL LOAD	**w**	t/ha	23.80
POTENTIAL FIRE LINE INTENSITY	**I**	kW/m	28785
RADIANT HEAT FLUX	**q**	kW/m^2	15.12
BUSHFIRE ATTACK LEVEL (AS 3959-2018)	**BAL**	-	BAL 19
DISCLAIMER: Fire-line intensity and radiant heat calculations where effective slope exceeds 20 degrees (downslope) or 15 degrees (upslope) may be unreliable. In these locations, specialist assessment is warranted.			

Table 15 State Planning Policy Asset Protection Zone Width Calculator (VHC 36.1- upslope/level with south)

SPP Bushfire Asset Protection Zone Width Calculator			
VARIABLE DESCRIPTION	**VARIABLE**	**UNITS**	**VALUE**
Input Values			
FIRE WEATHER SEVERITY	**FDI**		61.00
VEGETATION HAZARD CLASS	**VHC**	-	36.1 Exotic and hardwood plantation
REMNANT STATUS	**-**	-	Non-remnant
SLOPE TYPE (UPSLOPE OR DOWNSLOPE)	**ST**	-	Upslope/ level with
EFFECTIVE SLOPE UNDER THE HAZARDOUS VEGETATION	**eSlope**	degrees	1.00
SLOPE BETWEEN SITE AND HAZARDOUS VEGETATION	**θ**	degrees	1.00
DISTANCE OF THE SITE FROM HAZARDOUS VEGETATION	**d**	m	52.00
Output Values			
SURFACE FUEL LOAD	**-**	t/ha	22.30
NEAR SURFACE FUEL LOAD	**-**	t/ha	1.50
BARK FUEL LOAD	**-**	t/ha	1.20
ELEVATED FUEL LOAD	**-**	t/ha	1.00
TOTAL OVERALL FUEL LOAD	**W**	t/ha	26.00
TOTAL SURFACE FUEL LOAD	**w**	t/ha	23.80
POTENTIAL FIRE LINE INTENSITY	**I**	kW/m	23403
RADIANT HEAT FLUX	**q**	kW/m^2	9.76
BUSHFIRE ATTACK LEVEL (AS 3959-2018)	**BAL**	-	BAL 12.5
DISCLAIMER: Fire-line intensity and radiant heat calculations where effective slope exceeds 20 degrees (downslope) or 15 degrees (upslope) may be unreliable. In these locations, specialist assessment is warranted.			

Appendix D Explanation of Bushfire Attack Levels

Table 16 BAL Descriptions - Australian Standard - Construction of Buildings in Bushfire-prone Areas (AS 3959-2018)

				
BAL-12.5	BAL-19	BAL-29	BAL-40	BAL-FZ
The risk is considered to be LOW	The risk is considered to be MODERATE	The risk is considered to be HIGH.	The risk is considered to be VERY HIGH.	The risk is considered to be EXTREME.
There is a risk of ember attack. The construction elements are expected to be exposed to a heat flux not greater than 12.5 kW/m^2.	There is a risk of ember attack and burning debris ignited by wind borne embers and a likelihood of exposure to radiant heat. The construction elements are expected to be exposed to a heat flux not greater than 19 kW/m^2.	There is an increased risk of ember attack and burning debris ignited by windborne embers and a likelihood of exposure to an increased level of radiant heat. The construction elements are expected to be exposed to a heat flux not greater than 29 kW/m^2.	There is a much increased risk of ember attack and burning debris ignited by windborne embers, a likelihood of exposure to a high level of radiant heat and some likelihood of direct exposure to flames from the fire front. The construction elements are expected to be exposed to a heat flux not greater than 40 kW/m^2.	There is an extremely high risk of ember attack and burning debris ignited by windborne embers, and a likelihood of exposure to an extreme level of radiant heat and direct exposure to flames from the fire front. The construction elements are expected to be exposed to a heat flux greater than 40 kW/m^2.

Images sourced from Planning Practice Note 65 September 2014 Victoria State Government

Appendix E Living in a Bushfire Prone Area

A bushfire can ignite fuel and spread in three ways:

- Embers and burning debris carried by wind,
- Heat radiation from fire, and
- Direct flame contact.

	Ignition of buildings by burning embers carried by the wind
	Ignition of buildings by heat radiation from the fire
	Ignition of buildings by direct flame contact

Figure 17 The three main elements of bushfire which threaten life and property. (Ramsay & Rudolf 2003)

Overall, the intention of bush fire protection measures should be to prevent flame contact to a structure, reduce radiant heat to below the ignition thresholds for various elements of a building, to minimise the potential for wind driven embers to cause ignition and reduce the effects of smoke on residents and fire-fighters.

Whilst research shows that ember attack ultimately claims more vacant houses than radiant heat or flames, if a house is occupied, ember attack can be relatively easily dealt with. The consequence of leaving a house unattended is that there will probably be nobody there to prevent the small fires which initially start, from gradually taking hold of various parts of the structure. This process can occur over a significant period of time, usually simply with embers which fly about and settle, and start smouldering. The hot windy conditions associated with the fire help fan the smouldering clumps of fuel and bring many small fires to life. These are

usually easy fires to extinguish if there is someone there with the equipment and water to put them out. In their absence, often some time, even hours after the initial fire front, the house succumbs to small fires which have grown to larger ones.

Over 90% of houses burnt down in bushfires are attributable to ember attack, and the vast majority of these are unattended at the time. In the 1984 study of the Ash Wednesday Fires around Mt Macedon, the survival rate amongst the 450 houses was 82% where they were occupied and 90% where the occupants were active, able-bodied defenders, while only 30% of houses survived without someone to patrol them (Wilson & Ferguson, 1984).

Asset Protection Zones

The most immediate form of defence for an asset is a well-designed Asset Protection Zone (APZ). An APZ is a fuel reduced area surrounding a built asset or structure. This can include any residential building or major building such as farm and machinery sheds, or industrial, or commercial buildings.

Various amenities can contribute to the Asset Protection Zone, provided they are not combustible or otherwise they will add to radiant heat levels. Such amenities include driveways, tennis courts, swimming pools or fire trails, each adding to the distance from the hazard.

Radiant heat barriers such as non-combustible walls or water tanks can help shield assets from radiant heat, thereby complementing the APZ, and in some cases reducing the requirement for distance from the hazard to a degree.

An APZ provides:

- a buffer zone between a bush fire hazard and an asset;
- an area of reduced bush fire fuel that allows suppression of fire;
- an area from which backburning may be conducted; and
- an area which allows emergency services access and provides a relatively safe area for firefighters and homeowners to defend their property.

Potential bush fire fuels should be minimised within an APZ. This is so that the vegetation within the planned zone does not provide a path for the transfer of fire to the asset either from the ground level or through the tree canopy.

An APZ, if designed correctly and maintained regularly, will reduce the risk of:

- direct flame contact on the asset;
- damage to the built asset from intense radiant heat; and
- ember attack on the asset.

The APZ can be made up of an Inner Protection Area (IPA) and an Outer Protection Area (OPA).

Inner Protection Area (IPA)

The IPA is the area closest to the building and creates a fuel-managed area which can minimise the impact of direct flame contact and radiant heat on the development and act as a defendable space. Vegetation within the IPA should be kept to a minimum level. Litter fuels within the IPA should be kept below 1cm in height and be discontinuous.

In practical terms the IPA is typically the curtilage around the building, consisting of a mown lawn and well-maintained gardens.

When establishing and maintaining an IPA, the following requirements apply:

Trees

- tree canopy cover should be less than 15% at maturity;
- trees at maturity should not touch or overhang the building (preferably, there should be no trees within 10 metres of a dwelling);
- lower limbs should be removed up to a height of 2m above the ground; and
- tree canopies should be separated by 2 to 5m.

Shrubs

- create large discontinuities or gaps in the vegetation to slow down or break the progress of fire towards buildings should be provided;
- shrubs should not be located under trees;
- shrubs should not form more than 10% ground cover; and
- clumps of shrubs should be separated from exposed windows and doors by a distance of at least twice the height of the vegetation.

Grass

- grass should be kept mown (as a guide grass should be kept to no more than 100mm in height); and
- leaves and vegetation debris should be removed.

Outer Protection Area (OPA)

An OPA is located between the IPA and the unmanaged vegetation. It is an area where there is maintenance of the understorey and some separation in the canopy. The reduction of fuel in this area aims to decrease the intensity of an approaching fire and restricts the potential for fire spread from crowns, reducing the level of direct flame, radiant heat and ember attack on the IPA.

When establishing and maintaining an OPA the following requirements apply:

Trees

- tree canopy cover should be less than 30%; and
- canopies should be separated by 2 to 5m.

Shrubs

- shrubs should not form a continuous canopy; and
- shrubs should form no more than 20% of ground cover.

Grass

- grass should be kept mown to a height of less than 100mm; and
- leaf and other debris should be removed.

An APZ should be maintained in perpetuity to ensure ongoing protection from the impact of bushfires. Maintenance of the IPA and OPA as described above should be undertaken regularly, particularly in advance of the bush fire season.

The required distances for Asset Protection Zones are dependent on the vegetation type (hazard), the slope of the site and whether the hazard is upslope or downslope from the asset. An example of an APZ in relation to a dwelling is provided in Figure 18.

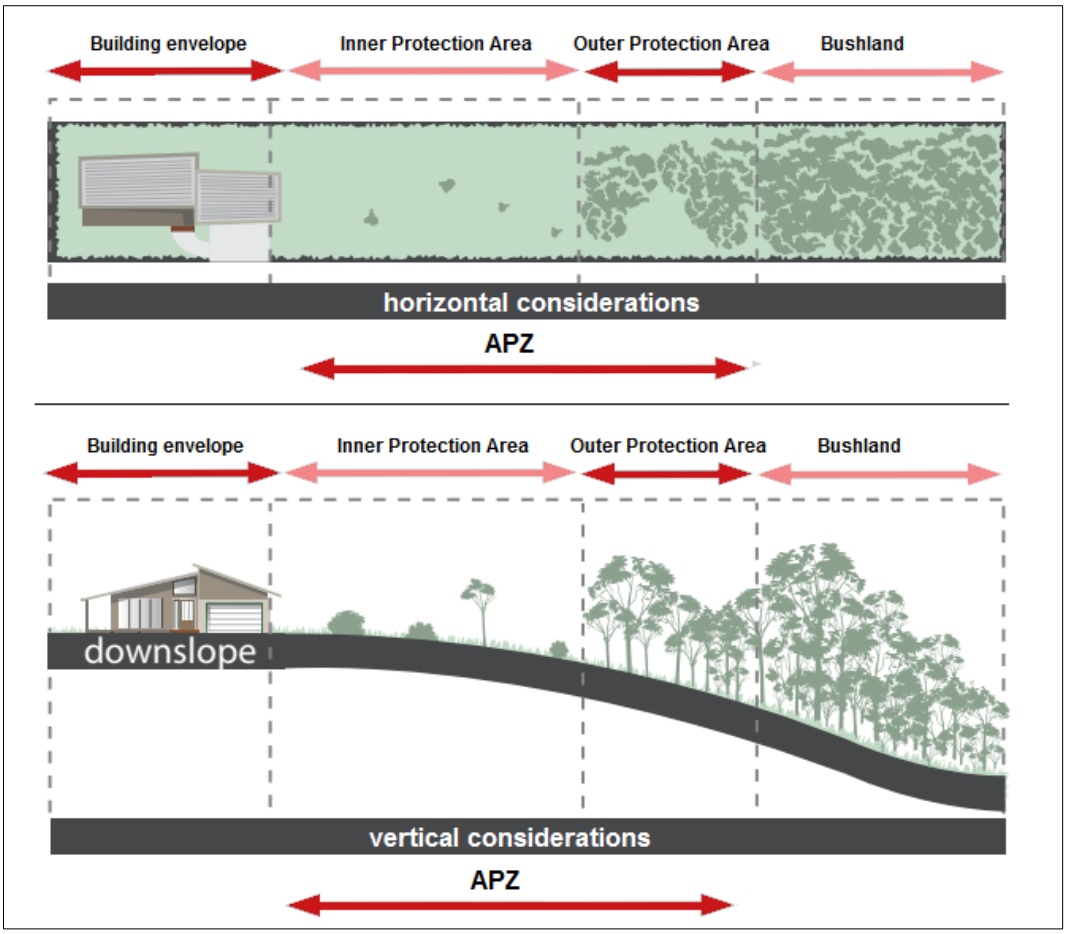


Figure 18 APZ Elements (Adapted from Planning for Bushfire Protection 2019)

Information presented in this Appendix was drawn from Planning for Bushfire Protection, A guide for councils, planners, fire authorities and developers (NSW Rural Fire Service November 2019) and Standards for Asset Protection Zones (NSW Rural Fire Service undated).

Appendix F Landscaping in Fire Prone Areas

The design, management, and maintenance of the landscape in the immediate vicinity of buildings are fundamental to the chances of survival of both people and buildings in a bushfire event. Vegetation provides the major fuel element in a bushfire. All vegetation, regardless of how succulent or green it is will eventually burn, provided the fire has sufficient intensity. When landscaping in bushfire prone areas, it is important to use or retain plants of low flammability that have the relevant characteristics as identified in Table 17.

Table 17 Characteristics of low flammability species and effect on performance in bushfire situations

Plant attribute	Effect	Design measure
Foliage moisture content	Leaves with higher moisture content retard ignition and slow the rate of combustion	Select species with high leaf moisture content (e.g., rainforest species, succulents, and semi-succulents)
Foliage volatile oil content	Foliage with higher volatile oil content ignite more readily and enhance ignition of surrounding vegetation, even though volatile oils themselves do not contribute significantly to total radiant heat	Select species with lower volatile oil content
Foliage mineral content	Foliage with higher mineral content tend to be less flammable (e.g., Amyema spp mistletoes)	Species selection should favour species with higher leaf mineral content
Leaf fineness	The ratio of area-to-volume of leaves is one of the main factors affecting ease of ignition and intensity of burning. Finer leaves (greater area to volume ratio) tend to ignite and burn more easily than broader leaves	Species selection should favour broad-leafed species
Density of foliage and continuity of plant form	Species with continuous, denser foliage can act as a barrier to wind-borne embers and radiant heat; however, increased density can increase flammability. Species with open branching and low foliage density are less effective as a barrier, though can be less flammable	Select species on a case-by-case basis
Height of lowest foliage	Shrub and tree species with persistent low height foliage are more likely to be ignited by surface fires, allowing the spread of fires into the canopy above	Species selection should favour species which can be maintained or pruned to reduce persistent, near-ground foliage
Size of plant (volume and spread)	The effect of plant size varies according to volume or spread. Species with a greater spread tend to be more effective as a barrier to the diffusion of radiant heat than narrower trees with the same volume. Species with a greater volume can result in increased ember attack, radiation and flame if ignited. For example, narrow columnar trees are	Species selection should ensure plant size (volume and spread) does not increase ignition likelihood

Plant attribute	Effect	Design measure
	less effective as a barrier than wider trees with the same overall volume	
Dead foliage on plant	Persistent dead leaves and woody twigs increase flammability	Species selection should favour species which have a low volume of persistent dead leaves and woody material or can be maintained or pruned to reduce persistent, dead leaves and woody material
Bark texture	Loose, flaky, stringy, papery, or ribbon-like bark contribute to ladder fuels which: • can contribute to destructive crown fires • act as a potential source of flame, radiant heat, and ember attack	Avoid species with persistent loose, flaky, stringy, papery, or ribbon-like bark. Species selection should favour smooth barked and tightly held bark species
Potential available surface fuel	The availability of surface fuel is a function of volume (quantity) and fineness. The fireline intensity increases in proportion to available fine fuel quantity. Fine fuel includes dead fallen material such as leaves, bark, twigs and branches up to 6mm in diameter (forest) and grass greater than 5cm in height (grasslands). Coarse fuel ignites less readily but may burn for longer	Species selection should favour species which do not contribute significantly to persistent, fine ground fuel

The characteristics of low flammability species and effect on performance in bushfire situations was sourced from the publication *Bushfire Resilient Communities, Technical Reference Guide for the State Planning Policy State Interest 'Natural Hazards, Risk and Resilience - Bushfire'*.

To assist building survival in a bushfire event, it is important that a fuel-reduced zone is maintained around it. This can be achieved by keeping all vegetation away from the building or by using low flammability plantings to help shield the building from radiant heat. Trees and shrubs that drop litter should not be planted or retained close to buildings where they can contribute to the accumulation of flammable material.

Ongoing maintenance of vegetation should be undertaken in the area surrounding the site to prevent hazardous fuel loads from occurring. These actions include:

- Pruning lower branches of trees to provide a minimum vertical 2-metre-high fire break;
- Removal of loose bark, dead twigs, leaves;
- Regular mowing of lawns;
- Keeping other grassed areas to less than 100mm in height;
- Use of non-flammable mulches such as river pebbles or stones on garden beds near buildings; and
- Avoidance of flammable mulches on garden beds such as woodchip or straw.

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